

# **SALMON AND STEELHEAD HABITAT LIMITING FACTORS**

**WATER RESOURCE INVENTORY AREA 25**

**WASHINGTON STATE  
CONSERVATION COMMISSION**

**FINAL REPORT**

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## **EXECUTIVE SUMMARY**

### **Introduction**

Section 10 of Engrossed Substitute House Bill 2496 (Salmon Recovery Act of 1998), directed the Washington State Conservation Commission, in consultation with local government and treaty tribes to invite private, federal, state, tribal, and local government personnel with appropriate expertise to convene as a Technical Advisory Group (TAG). The purpose of the TAG is to identify habitat limiting factors for salmonids. Limiting factors are defined as “conditions that limit the ability of habitat to fully sustain populations of salmon, including all species of the family Salmonidae.” The bill further clarifies the definition by stating “These factors are primarily fish passage barriers and degraded estuarine areas, riparian corridors, stream channels, and wetlands.” It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis.

This report is based on a combination of existing watershed studies and the personal experience and knowledge of the TAG participants. WRIA 25 is located in Southwest Washington within portions of Lewis, Cowlitz, and Pacific Counties. This area encompasses numerous tributaries to the Columbia River including Coal Creek, Germany Creek, Abernathy Creek, Mill Creek, Elochoman River, Skamokawa Creek, Grays River, and Deep River (see Map 4 in Map Appendix). This report also includes tributaries to the Columbia River in WRIA 24 including the Chinook and Wallacut Rivers. Five stocks of anadromous salmon and steelhead, and coastal cutthroat trout return to the rivers. For purposes of this analysis WRIA 25 was separated into three subbasins; Mill/Germany/Abernathy, Elochoman/Skamokawa, and the Grays. Streams within WRIA 24 were included in the Grays River Subbasin.

### **WRIA 25 Habitat Limiting Factors**

The major habitat limiting factors common to most streams within WRIA 25 included:

- **Access:** Several artificial passage barriers were identified that are either known barriers or barriers that need additional assessment. A number of the major fish passage barriers in WRIA 25 have been fixed or are slated for repair in the near future.
- **Floodplain Connectivity:** Floodplain connectivity and access to off-channel and wetland habitat within the WRIA has been affected by management practices including diking, tidegates, stream channelization, channel hardening and the historic practice of splash damming. Significant floodplain protection and restoration projects have begun within the lower Chinook and Grays Rivers.
- **Side Channel Availability:** Similar practices that have reduced floodplain connectivity have also reduced side channel habitat. A combination of limiting

factors has resulted in an overall reduction in channel complexity. Most of the streams in WRIA 25 can be characterized as having a single thread channel.

- **Bank Erosion / Stability:** Stream surveys identified several areas of active bank erosion. These areas are typically associated with alluvial soil with little or no riparian vegetation. Although data was not readily available to assess bank stability, TAG members noted that bank instability and mass wasting are significant limiting factors within many of the streams systems of WRIA 25.
- **Riparian conditions:** Riparian conditions are poor along most streams within the three subbasins. Loss of riparian function affects water quality, erosion rates, streambank stability, and instream habitat conditions.
- **Large Woody Debris:** Almost throughout WRIA 25, LWD abundance was below habitat standards. Adequate large woody debris in streams, particularly larger key pieces, is critical to developing pools, collecting spawning gravels, and providing habitat diversity and cover for salmonids.
- **Percent Pool:** Although stream surveys identified isolated areas with a “Fair” to “Good” percentage of pool habitat, in most streams pool habitat was well below habitat rating standards.
- **Water quality:** Elevated stream temperatures are the major water quality issue within WRIA 25; likely impacting juvenile salmonids and resident fisheries during summer months. With the onset of fall freshets, water temperatures appear to quickly return to levels satisfying spawning water quality criteria.
- **Water Quantity:** Both low and elevated peak flows were identified as limiting factors in most of the watersheds in WRIA 25.
- **Biological Processes:** Escapement goals are not being met for almost all stocks of salmon and steelhead returning to the rivers and streams of WRIA 25. Subsequently, the lack of nutrients may be limiting productivity.

## **Chinook-Grays Subbasin**

### Habitat Limiting Factors

#### *Access*

Several culvert sites and natural barriers were identified that require additional assessment to determine passage problems in this subbasin. Tidegates in the Chinook River impact fish passage and tidal/estuarine influence. Low flows were identified as a concern in Deep River, Seal River, the lower West Fork Grays River, and the section of the main stem Grays River between the Covered Bridge and the Canyon. Low flow concerns may be associated with the accumulation of bedload in the West Fork and main stem Grays River. TAG members also identified potential passage problems over the Grays Bay bar.

### *Floodplain Connectivity / Side Channel*

Most of the streams within the subbasin have been divorced from their floodplains and development of side channel habitats discouraged by several management practices particularly in the lower reaches of the watersheds. Practices include flood control measures, bank hardening, and channelization to improve agriculture and splash damming. Surveys conducted by the Conservation District indicate that the available side channel habitat is limited and highly transient in nature.

### *Sediment / Bank Stability*

The Grays River flows through areas with extremely unstable soils and geology. This natural instability, combined with extensive road construction and timber management, has lead to substantial sediment loads and unstable, aggrading stream channels. The extent of impacts to fish production from spawning substrate instability is unknown, but often considered the major limiting factor for chum and chinook salmon production the watershed.

### *Riparian Conditions*

Riparian conditions fell below Habitat Rating Standards almost throughout the Subbasin. Exceptions included East Fork Grays, and Mitchell, Alder, Sage, and Cabin Creeks.

### *Channel Conditions*

Stream surveys have found that the pieces of LWD/mile and the percentage of pool habitat fall well below habitat standards in most of the watersheds in this Subbasin. Channels have frequently been simplified through channelization, diking, splash damming, and the removal of LWD.

### *Water Quality*

Elevated stream temperatures impact juvenile salmonids and resident fish, and may impact migrating fish in the early fall. Fall freshets tend to rapidly cool stream temperature to current guidelines for spawning salmonids.

Turbidity was identified as a concern in Hendrickson Creek (Deep River), “Muddy Trib” (tributary to Grays River), West Fork Grays River and South Fork Grays River. Turbidity is elevated due to mass wasting and bank instability.

### *Water Quantity*

Both low flows and elevated peak flows were identified as limiting factors in many of the streams within the Grays River Subbasin. Bedload accumulations increase low flow problems in the mainstem Grays and West Fork Grays Rivers. High Road densities and hydrologic maturity contribute to elevated peak flows in all areas of the Subbasin.

### Habitats in Need of Protection

Priority habitats in need of protection include, chum and chinook salmon spawning areas in the mainstem Grays, steelhead spawning and rearing areas in the East Fork Grays

River and Mitchell Creek, and floodplain/estuarine habitats in Grays Bay and the Chinook River. Critical spawning habitat in the Chinook River is located just above the Sea Resources Hatchery and in upper watershed tributaries.

### Data Gaps

Information was lacking on habitat conditions in several tributary streams to the Grays River including Sweigler Creek, Crazy Johnson Creek, Johnson Creek and the upper reaches of the South Fork Grays River. Data was also lacking on most habitat conditions within tributaries to the Columbia in WRIA 24. Information was not available to completely address all of the limiting factors. Particular information needs include:

- Information is lacking on the quantity and quality of floodplain, side channel, estuary, or wetland habitats, and the loss of these habitats due to various land use activities.
- Stream surveys noted localized bank erosion, but data is lacking on overall bank stability.
- Little water quality information beyond stream temperature data is available within the subbasin. Only surrogate information for changes in water quantity is available within the subbasin
- Data was lacking on fish distribution by life-history stage, abundance, and productivity.
- Mass wasting was considered a significant limiting factor for chum and chinook salmon in the Grays River watershed. Data was lacking to identify specific areas of mass wasting, bank instability, and chronic erosion, to understand hydrology and sediment transport, and to identify appropriate actions to reduce sediment inputs.

### Recommendations for addressing Limiting Factors

The report contains a prioritized list of limiting factors and identifies actions for both restoration and protection of salmonid habitat in the Assessment chapter.

## **Skamokawa-Elochoman Subbasin**

### Habitat Limiting Factors

#### *Access*

Several culvert sites were identified that require further assessment. Wahkiakum Conservation District is in the process of collecting information on public culverts in the subbasin. Forest industry representatives indicated that they are in the process of evaluating road and culvert condition to satisfy forest practices requirements.

#### *Floodplain Connectivity / Side Channel Availability*

Most of the streams within the subbasin have been disconnected from their floodplains and the development of side channel habitats discouraged by several management practices, particularly in the lower reaches of the watersheds. Practices include flood control measures, bank hardening, and channelization and draining to improve agriculture

and splash damming. Floodplain connectivity was considered to be in good condition within the Jim Crow Creek watershed.

Surveys conducted by the Conservation District indicate that side channel habitat is limited and highly transient in nature.

#### *Bank Erosion / Bank Stability*

Bank erosion problems were generally noted in areas with alluvial deposits and with little or no woody vegetation. Bank erosion was extensive throughout the agriculture areas in the Skamokawa Creek watershed. A combination of conditions affect stability in these areas including alluvial soils, an entrenched stream channel, lack of riparian vegetation, and upper watershed conditions that may have increased peak flows. Bank stability problems occur in the West Fork Elochoman and North Fork Elochoman due to mass wasting. The lower reaches of Germany Creek are currently responding to increased inputs of coarse sediment load from past land use activities.

#### *Fine Sediment*

Sediment fines are a significant problem in the subbasin. Numerous mass-wasting events occur in both the Elochoman and Skamokawa watersheds. The North Elochoman Watershed Analysis identified shallow rapid landslides associated with forest practices and roads as major contributors of fine sediment to the stream system.

#### *Riparian Condition*

Riparian conditions did not meet the Habitat Rating Standards almost throughout the Subbasin. Standard Creek in the Skamokawa Creek watershed was a notable exception, with a “good” rating.

#### *Channel Conditions*

Stream surveys have found that the pieces of LWD/mile and the percentage of pool habitat fall well below habitat standards in most of the watersheds in this Subbasin. Channels have frequently been simplified through channelization, diking, splash damming, and the removal of LWD. Areas in the upper watershed and tributary streams with a greater percentage of pool habitat also tend to be the areas with more LWD.

#### *Water Quality*

Elevated water temperatures likely impact rearing juveniles and resident fish, and potentially migrating fish in the early fall. Fall freshets tend to rapidly cool water temperatures to current guidelines for spawning salmonids.

#### *Water Quantity*

Low flows problems were identified in the section of the Elochoman River from the Beaver Creek hatchery upstream to the West Fork Grays River. Hydrologic immaturity and high road densities potentially increase peak flows in the most watersheds in the Subbasin. Low flows likely limit the available rearing habitat during summer months.

### Priority Habitats

- Side channels in the upper segments of Wilson, Falk, and Left Fork Skamokawa Creeks provide critical habitat.
- Floodplain habitats are limited and need protection wherever they occur.
- Crippen and Standard Creeks contain some of the best and most productive habitat for steelhead in the subbasin.
- Identify and protect cooler water refuges such as Falk Creek.

### Skamokawa-Elochoman Subbasin Data Gaps

Information on habitat conditions and fish passage problems was incomplete in the Subbasin. Specific data needs included:

- Water quality data is lacking for many stream systems.
- Stream surveys have not been completed for Standard and McDonald Creeks in the Skamokawa Creek watershed, and in Alger, Risk, and Birnie Creeks.
- Data was lacking on fish distribution by life-history stage, abundance, and productivity.
- Potential fish passage barriers have been identified but an assessment has not been completed to determine the extent of passage problems and the quality of upstream habitat.
- Information is lacking on the effects of tidegates and other water control structures.
- Surveys are needed to identify opportunities to restore side-channel in important spawning and rearing areas, especially in the Elochoman River.

### **Abernathy/Mill/Germany Subbasin**

#### Habitat Limiting Factors

##### *Access*

Several culvert sites were identified that require further assessment to determine passage problems. Wahkiakum Conservation District is in the process of collecting information on public culverts in the subbasin. Forest industry representatives are in the process of evaluating road and culvert condition to satisfy forest practices requirements. Fish ladders on Cameron Creek (Abernathy tributary) and upstream of the Abernathy Fish Technology Center require constant maintenance. Shallow flows across bedrock may limit access to Slide Creek (Abernathy tributary). Pumping stations restrict fish access to the streams in the Longview area.

##### *Floodplain Connectivity / Side Channel Availability*

Splash damming on Mill and Abernathy Creek has disconnected the stream from its floodplain. Conditions improve in the upper watershed. Stream adjacent roads confine

the stream channel throughout this subbasin. Side channels are rare within the subbasin. Conservation District stream surveys noted that most side channels were typically short, associated with accumulation of bedload, and appear highly transient in nature.

#### *Bank Erosion / Bank Stability*

Stream surveys found limited areas with active bank erosion. However, mass wasting in the upper watersheds has deposited excessive bedload in many stream channels.

#### *Riparian Condition*

Overall riparian conditions rated “poor” in the Subbasin. Some exceptions included Weist, Erick, and Midway Creeks in the Abernathy Creek watershed.

#### *Channel Conditions*

Stream surveys found that the pieces of LWD/mile and the percentage of pool habitat fell well below habitat standards in most of the watersheds in this Subbasin. Channels have frequently been simplified through channelization, diking, splash damming, and the removal of LWD. In general, areas in the upper watershed and tributary streams with a “Fair” or “Good” percentage of pool habitat also tend to be the areas with “Fair” and “Good” LWD ratings.

#### *Water Quality*

Elevated stream temperatures likely impact rearing juveniles and resident fish, and potentially migrating fish in the early fall. Fall freshets tend to rapidly cool stream temperatures to current guidelines for spawning salmonids.

Aluminum toxicity has been identified as a concern in the Mill and Cameron Creeks. Heavy metals concentrations are elevated in Lake Sacajawea and the Longview ditches. High turbidity impacts water quality in the Longview ditches and in the Coal Creek.

#### *Water Quantity*

Hydrologic immaturity and high road densities potentially increase peak flows in the most watersheds in the Subbasin. Low flows likely limit the available rearing habitat during summer months.

#### Priority Habitats

- From RM 10 to RM 12 Mill Creek flows through a series of wetlands with quality side channel habitat and connected floodplains. The upper reaches of Abernathy also provide excellent rearing and spawning habitat.
- Identify and protect limited chum spawning sites in the subbasin.
- Preserve and enhance floodplain connectivity in lower Germany Creek.

#### Mill/Germany/Abernathy Subbasin Data Gaps

- Stream survey data has been completed on only 8 miles of stream in the Mill Creek watershed. Cowlitz Conservation District intends to complete surveys during summer of 2001.
- Germany Creek watershed has received large sediment in recent years. This sediment load is now moving downstream, reducing channel and streambed stability. Information regarding mass wasting and sediment transport is needed to identify sensitive areas, identify causal mechanisms, and assess impacts to the stream system.

**The following chapters provide a detailed assessment of the habitat limiting factors within WRIA 25.**

## **INTRODUCTION**

### **Habitat Limiting Factors Background**

The successful recovery of naturally spawning salmon populations depends upon directing actions simultaneously at harvest, hatcheries, habitat and hydro, the 4H's. The 1998 state legislative session produced a number of bills aimed at salmon recovery. Engrossed Substitute House Bill (ESHB) 2496 is a key piece of the 1998 Legislature's salmon recovery effort, with the focus directed at salmon habitat issues. Engrossed Substitute House Bill (ESHB) 2496 in part:

- directs the Conservation Commission in consultation with local government and the tribes to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group;
- directs the technical advisory group to identify limiting factors for salmonids to respond to the limiting factors relating to habitat pursuant to section 8 sub 2 of this act;
- defines limiting factors as "conditions that limit the ability of habitat to fully sustain populations of salmon."
- defines salmon as all members of the family salmonidae, which are capable of self-sustaining, natural production.

The overall goal of the Conservation Commission's limiting factors project is to identify habitat factors limiting production of salmonids in the state. At this time, the report identifies habitat limiting factors pertaining to salmon, steelhead trout and include bull trout when they share the same waters with salmon and steelhead. Later, we will add bull trout-only waters, as well as specific factors that relate to cutthroat.

It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis. The hatchery, hydro and harvest segments of identifying limiting factors are being dealt with in other forums.

### **The Relative Role of Habitat in Healthy Populations of Natural Spawning Salmon**

During the last 10,000 years, Washington State salmon populations have evolved in their specific habitats (Miller 1965). Water chemistry, flow, and the physical stream components unique to each stream have helped shape the characteristics of each salmon population, which has resulted in a wide variety of distinct salmon stocks for each salmon species throughout the State. Within a given species, stocks are units that do not extensively interbreed because returning adults rely on a stream's unique chemical characteristics to guide them to their natal grounds to spawn. This maintains the separation of stocks during reproduction, thus maintaining the distinctiveness of each stock.

Throughout the salmon's life cycle, the dependence between the stream and a stock continues. Adults spawn in areas near their own origin because survival favors those that do. The timing of juveniles leaving the river and entering the estuary is tied to high natural river flows. It is thought that the faster speed during out-migration reduces predation on the young salmon and perhaps is coincident to favorable feeding conditions in the estuary (Wetherall 1972). These are a few examples that illustrate how a salmon stock and its environment are intertwined throughout the entire life cycle.

Salmon habitat includes the physical, chemical and biological components of the environment that supports salmon. Within freshwater and estuarine environments, these components include water quality, water quantity or flows, channel physical features, riparian zones, sediment regime, upland conditions, and ecosystem interactions as they pertain to habitat. However, these components closely intertwine. Low stream flows can alter water quality by increasing temperatures and decreasing oxygen levels. The riparian zone interacts with the stream environment, providing nutrients and a food web base, large woody debris for habitat and flow control (stream features), filtering water prior to stream entry (water quality), sediment control and bank stability, and shade to aid in temperature control.

Salmon habitat includes clean, cool, well-oxygenated water flowing at a normal (natural) rate for all stages of freshwater life. In addition, salmon survival depends upon specific habitat needs for the different life history stages, which include egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, adult migration to spawning areas, and spawning. These specific needs can vary by species and even by stock.

When adult salmon return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to their natal grounds. They need deep pools for resting with vegetative cover and instream structures such as root wads for shelter from predators. Successful spawning depends on sufficient gravel of the right size for that particular population, in addition to the constant need of adequate flows and water quality, all in unison at the necessary location. Delayed upstream migration can be critical. After entering freshwater, most salmon have a limited time to migrate and spawn, in some cases, as little as two to three weeks. Delays can result in pre-spawning mortality or spawning in a sub-optimum location.

After spawning, the eggs need stable gravel that is not choked with sediment. River channel stability is vital at this life history stage for all species of salmonids. Floods have their greatest impact to salmon populations during incubation, and flood impacts are worsened by human activities that alter stream hydrology. In a natural river system, the upland areas are forested, and the trees and their roots store precipitation, which slows the rate of storm water into the stream, lessening the impact of a potential flood. The natural, healthy river is sinuous and contains numerous large pieces of wood contributed by an intact, mature riparian zone. Both reduce the energy of water moving downstream. Natural systems have floodplains that are connected directly to the river at many points, allowing wetlands to store flood water and later discharge this storage back to the river

during lower flows. This not only decreases flood impacts, but also recharges fish habitat later when flows are low. In a healthy river, erosion or sediment input is great enough to provide new gravel for spawning and incubation, but does not overwhelm the system, raising the riverbed and increasing channel instability. Lastly, a natural river system allows floodwaters to freely flow over unaltered banks rather than constraining the energy within the channel, scouring out salmon eggs. A stable egg incubation environment is essential for all salmon, and is a complex function of nearly all habitat components.

Once the young fry leave their gravel nests, certain species such as chum, pink and some chinook salmon quickly migrate downstream to the estuary. Other species, such as coho, steelhead, bulltrout, and chinook, will search for suitable rearing habitat within the side sloughs, side-channels, spring-fed “seep” areas, as well as the outer edges of the stream. These quiet-water side margin and off-channel slough areas are vital for early juvenile habitat. The presence of woody debris and overhead cover aid in food and nutrient inputs as well as provide protection from predators. For most of these species, juveniles use this type of habitat in the spring. Most sockeye salmon populations quickly migrate from their gravel nests to larger lake environments where they have unique habitat requirements. These include water quality sufficient to produce the necessary complex food web to support one to three years of salmon growth in that lake habitat prior to outmigration to the estuary.

As growth continues, the juveniles (parr) move away from the quiet shallow areas to deeper, faster areas of the stream. These include coho, steelhead, bulltrout, and certain chinook. For some of these species, this movement is coincident with the summer low flows. Low flows constrain salmon production for stocks that rear within the stream. In non-glacial streams, summer flows are maintained by precipitation, connectivity to wetland discharges, and groundwater inputs. Reductions in these inputs will reduce the amount and quality of habitat; hence the number of salmon from these species.

In the fall, juvenile salmon that remain in freshwater begin to move out of the mainstems, and again, off-channel habitat becomes important. During the winter, coho, steelhead, bulltrout, and remaining chinook need habitat to sustain their growth and protect them from predators and winter flows. Wetlands, off-channel habitat, undercut banks, rootwads, and pools with overhead cover are important habitat components during this time.

Except for bulltrout and resident steelhead, juvenile parr convert to smolts as they migrate downstream towards the estuary. Again, flows are critical, and food and shelter are necessary. The natural flow regime in each river is unique, and has shaped the population’s characteristics through adaptation over the last 10,000 years. Because of the close inter-relationship between a salmon stock and its stream, survival of the stock depends on natural flow patterns, particularly during migration times.

The estuary provides an ideal area for rapid growth, and some salmon species are heavily dependent on estuaries, particularly chinook, chum, and to a lesser extent, pink salmon. Estuaries contain new food sources to support the rapid growth of salmonid smolts, so adequate natural habitat must exist to support the detritus-based food web, such as eelgrass beds, mudflats, and salt marshes. Also, the processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as lack of woody debris and sediment transport.

All salmonid species need adequate flow, similar water quality, spawning riffles and pools, a functional riparian zone, and upland conditions that favor stability, but some of these specific needs vary by species, such as preferred spawning areas and gravel. Although some overlap occurs, different salmon species within a river are often staggered in their use of a particular type of habitat. Some are staggered in time, and others are separated by distance.

Chum and pink salmon use the streams the least amount of time. Washington State adult pink salmon typically begin to enter the rivers in August and spawn in September and October, although Dungeness summer pinks enter and spawn a month earlier (WDFW and WWTIT 1994). During these times, low flows and associated high temperatures and low dissolved oxygen can be problems. Other disrupted habitat components, such as a shallow and less frequent pools due to elevated sediment inputs and lack of canopy from an altered riparian zone or widened river channel, can worsen these flow and water quality problems because there are fewer refuges for the adults to hold prior to spawning.

The pink salmon fry emerge from their gravel nests in February to April, and migrate downstream to the estuary within a month. After a limited rearing time in the estuary, pink salmon migrate to the ocean for a little over a year, until the next spawning cycle. Most pink salmon stocks in Washington are only in the rivers in odd years. The exception is the Snohomish Basin, which supports two pink salmon stocks. One stock spawns in odd years, and the other stock spawns in even years.

In Washington, adult chum salmon (3-5 years old) have three major run types. Summer chum enter the rivers in August and September, and spawn in September and October. Fall chum adults enter the rivers in late October through November, and spawn in November and December. Winter chum enter from December through January and spawn from January through February. Chum salmon fry emerge from the nests in March and April, and quickly outmigrate to the estuary for rearing. In the estuary, juvenile chum follow prey availability. In Hood Canal, juveniles that arrive in the estuary in February and March migrate rapidly offshore. This migration rate decreases in May and June as levels of zooplankton increase. Later as the food supply dwindles, chum move offshore and switch diets (Simenstad and Salo 1982). Both chum and pink salmon have similar habitat needs such as unimpeded access to spawning habitat, a stable incubation environment, favorable downstream migration conditions (adequate flows in

the spring), and because they rely heavily on the estuary for growth, good estuary habitat is essential.

Chinook salmon have three major run types in Washington State. Spring chinook are in their natal rivers throughout the calendar year. Adults begin river entry as early as February in the Chehalis Basin, but in Puget Sound, entry doesn't begin until April or May. Spring chinook spawn from July through September and typically spawn in the headwater areas where higher gradient habitat exists. Incubation continues throughout the autumn and winter and generally requires more time for the eggs to develop into fry because of the colder water temperatures in the headwater areas. Fry begin to leave the gravel nests in February through early March. After a short rearing period in the shallow side margins and sloughs, all Puget Sound and coastal spring chinook stocks have a component of the juvenile population that begin to leave the rivers to the estuary over the next several months, lasting until August. Within the Puget Sound stocks, it is not uncommon for other juveniles to remain in the river for another year before leaving as yearlings, so that a wide variety of outmigration strategies are used by these stocks. The juveniles of spring chinook stocks in the Columbia Basin exhibit more distinct juvenile life history characteristics. Generally, these stocks remain in the river for a full year. However, some stocks migrate downstream from their natal tributaries in the fall and early winter into larger rivers, including the mainstem Columbia River, where they are believed to over-winter prior to outmigration the next spring as yearling smolts.

Summer chinook begin river entry as early as June in the Columbia, but not until August in Puget Sound. They generally spawn in September or October. Fall chinook stocks range in spawn timing from late September through December. All Washington State summer and fall chinook stocks have juveniles that incubate in the gravel until January through early March, and downstream migration to the estuaries occurs over a broad time period (January through August). A few of these stocks have a component of juveniles that remain in freshwater for a full year after emerging from the gravel nests.

While some emerging chinook salmon fry outmigrate quickly, most inhabit the shallow side margins and side channels for up to two months. Then, some gradually move into the faster areas to rear, and others outmigrate to the estuary. Most summer and fall chinook outmigrate within their first year of life, but a few stocks (Snohomish summer chinook, Snohomish fall chinook, upper Columbia summer chinook) have juveniles that remain in the river for an additional year, similar to many spring chinook (Marshall et al, 1995). However, those in the upper Columbia, have scale patterns that suggest that they rear in a reservoir-like environment (mainstem Columbia River upstream from a dam) rather than in their natal streams and it is unknown whether this is a result of dam influence or whether it is a natural pattern.

The onset of coho salmon spawning is tied to the first significant fall freshet (Chuck Baranski, WDFW, personal communication). Adults typically enter freshwater from September to early December, but have been observed as early as late July and as late as mid-January (WDF et al. 1993). They often mill near the river mouths or in lower river

pools until freshets occur. Spawning usually occurs between November and early February, but is sometimes as early as mid-October and can extend into March. Spawning often occurs in tributaries and sedimentation in these tributaries can be a problem, with fine sediments suffocating eggs and excess coarse sediment decreasing channel stability. As chinook salmon fry exit the shallow low-velocity rearing areas, coho fry enter the same areas for the same purpose. As they grow, juveniles move into faster water and disperse into tributaries and areas which adults cannot access (Neave 1949). Pool habitat is important not only for returning adults, but for all stages of juvenile development. Preferred pool habitat includes deep pools with riparian cover and woody debris.

All coho juveniles remain in the river for a full year after leaving the gravel nests, but during the summer after early rearing, low flows can lead to problems such as physical reduction of available habitat, increased stranding, decreased dissolved oxygen, increased water temperature, and increased predation. Juvenile coho are highly territorial and can occupy the same area for a long period of time (Hoar 1958). The abundance of coho can be limited by the number of suitable territories available (Larkin 1977). Streams with more structure (logs, bushes, etc.) support more coho (Scrivener and Andersen 1982), not only because they provide more territories, but they also provide more food and cover. There is a positive correlation between their primary diet of insect material in their stomachs and the extent the stream was overgrown with vegetation (Chapman 1965). In addition, the leaf litter in the fall contributes to aquatic insect production (Meehan et al. 1977).

In the autumn as the temperatures decrease, juvenile coho move into deeper pools, and hide under logs, tree roots, and undercut banks (Hartman 1965). The fall freshets redistribute them (Scarlett and Cederholm 1984) and over-wintering generally occurs in available side channels, spring-fed ponds, and other off-channel sites to avoid winter floods (Peterson 1980). The lack of side channels and small tributaries may limit coho survival (Cederholm and Scarlett 1981). As coho juveniles grow into yearlings, they become more predatory on other salmonids. Coho begin to leave the river a full year after emerging from their gravel nests with the peak outmigration occurring in early May. Coho use estuaries primarily for interim food while they adjust physiologically to saltwater.

Sockeye salmon have a wide variety of life history patterns, including landlocked populations of kokanee which never enter saltwater. Of the populations that migrate to sea, adult freshwater entry varies from spring for the Quinault stock, summer for Ozette and Columbia River stocks, and summer and fall for Puget Sound stocks. Spawning ranges from September through February, depending on the stock.

After fry emerge from the gravel, most migrate to a lake for rearing, although a few types of fry migrate to the sea. Lake rearing ranges from one to three years with most juveniles rearing two years. In the spring after lake rearing is completed, juveniles enter the ocean where more growth occurs prior to adult return for spawning.

Sockeye spawning habitat varies widely. Some populations spawn in rivers (Cedar River) while other populations spawn along the beaches of their natal lake (Ozette), typically in areas of upwelling groundwater. Sockeye also spawn in side channels and spring-fed ponds. The spawning beaches along lakes provide a unique habitat that is often altered by human activities, such as pier and dock construction, dredging, sedimentation, and weed control.

Steelhead have one of the most complex life history patterns of any Pacific salmonid species (Shapovalov and Taft 1954). In Washington, there are two major run types, winter and summer steelhead. Winter steelhead begin river entry in a mature reproductive state in December and generally spawn from February through May. Summer steelhead enter the river from about May through October with spawning from about February through April. They enter the river in an immature state and require several months to mature (Burgner et al. 1992). Summer steelhead usually spawn farther upstream than winter stocks (Withler 1966) and dominate inland areas such as the Columbia Basin. Coastal streams support more winter steelhead populations.

Juvenile steelhead can either migrate to sea (anadromy) or remain in freshwater as rainbow trout. In Washington, those that are anadromous usually spend one to three years in freshwater, with the greatest proportion spending two years (Busby et al. 1996). Because of this and their year-round presence in steelhead-bearing streams, steelhead greatly depend on the quality and quantity of freshwater habitat.

Bulltrout/Dolly Varden stocks are also very dependent on the freshwater environment, where they reproduce only in clean, cold, relatively pristine streams. Within a given stock, some adults remain in freshwater their entire lives, while others migrate to the estuary where they rear during the spring and summer. They then return upstream to spawn in late summer. Those that remain in freshwater either stay near their spawning areas as residents, or migrate upstream throughout the winter, spring, and early summer, residing in pools. They return to spawning areas in late summer. In some stocks juveniles migrate downstream in spring, overwinter in the lower river, then enter the estuary and Puget Sound the following late winter to early spring (WDFW 1998). Because these life history types have different habitat characteristics and requirements, bulltrout are generally recognized as a sensitive species by natural resource agencies. Reductions in their abundance or distribution are inferred to represent strong evidence of habitat degradation.

In addition to the above-described relationships between various salmon species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years such that the survival of one species might be enhanced or impacted by the presence of another. Pink and chum salmon fry are frequently food items of coho smolts, Dolly Varden charr, and steelhead (Hunter 1959). Chum fry have decreased feeding and growth rates when pink salmon juveniles are abundant (Ivankov and Andreyev 1971),

probably the result of occupying the same habitat at the same time and competing for food items. These are just a few examples.

Most streams in Washington are home to several salmonid species, which together, rely upon freshwater and estuary habitat the entire calendar year. As the habitat and salmon review indicated, there are complex interactions between different habitat components, between salmon and their habitat, and between different species of salmon. For just as habitat dictates salmon types and production, salmon production contributes to habitat and to other species.

Coastal cutthroat have four life-history forms including anadromous (sea-run), fluvial (riverine), adfluvial (lacustrine), and resident (headwaters). Depending on specific watershed characteristics, all forms can occur within the same watershed. Coastal cutthroat exhibit the broadest range of occupied habitats, migratory behavior, age at first spawning, and frequency of repeat spawning of any salmonids (Johnson 1981; Northcote 1997 as cited in WDFW 2000).

Anadromous coastal cutthroat typically spawn in small streams. In Washington, most anadromous coastal cutthroat spawn from January through April, with the peak of spawning in February. Spawning occurs in riffles where the water depth is about 15 to 45 cm, in areas of low gradient and low flow (Johnson 1981, Trotter 1989 as cited in WDFW 2000). Adults surviving after spawning tend to return to salt water in late March and early April (Trotter 1989 as cited in WDFW 2000) Survival after spawning and the number of times adults return to spawn during its lifetime is variable, but individuals may return to spawn as often as 6 times (Johnson et. al. 1999).

Eggs hatch within six to seven weeks, and alevins remain in gravel for about two weeks after hatching (Trotter 1989). Fry emerge from spawning gravels from March through June (Johnson et. al. 1999). Newly emerged fry move quickly to low-velocity water at stream margins and backwaters and remain there through the summer to feed (Trotter 1989). Most juveniles remain in freshwater for two to four years before smolting and migrating to salt water, though the range extends from one to six years (Giger 1972 Lowery 1975 as cited in WDFW 2000). Emigration occurs in spring.

Upon reaching salt water most coastal cutthroat are thought to remain fairly close to shore or within estuaries. After feeding in salt water for several months most coastal cutthroat return to freshwater to overwinter and spawn. Fish returning to larger river systems with higher summer flows tend to enter from August through October, while those returning to smaller streams with lower summer flows tend to return from November through March (WDFW 2000).

## **WATERSHED CONDITION**

### **WRIA Characterization**

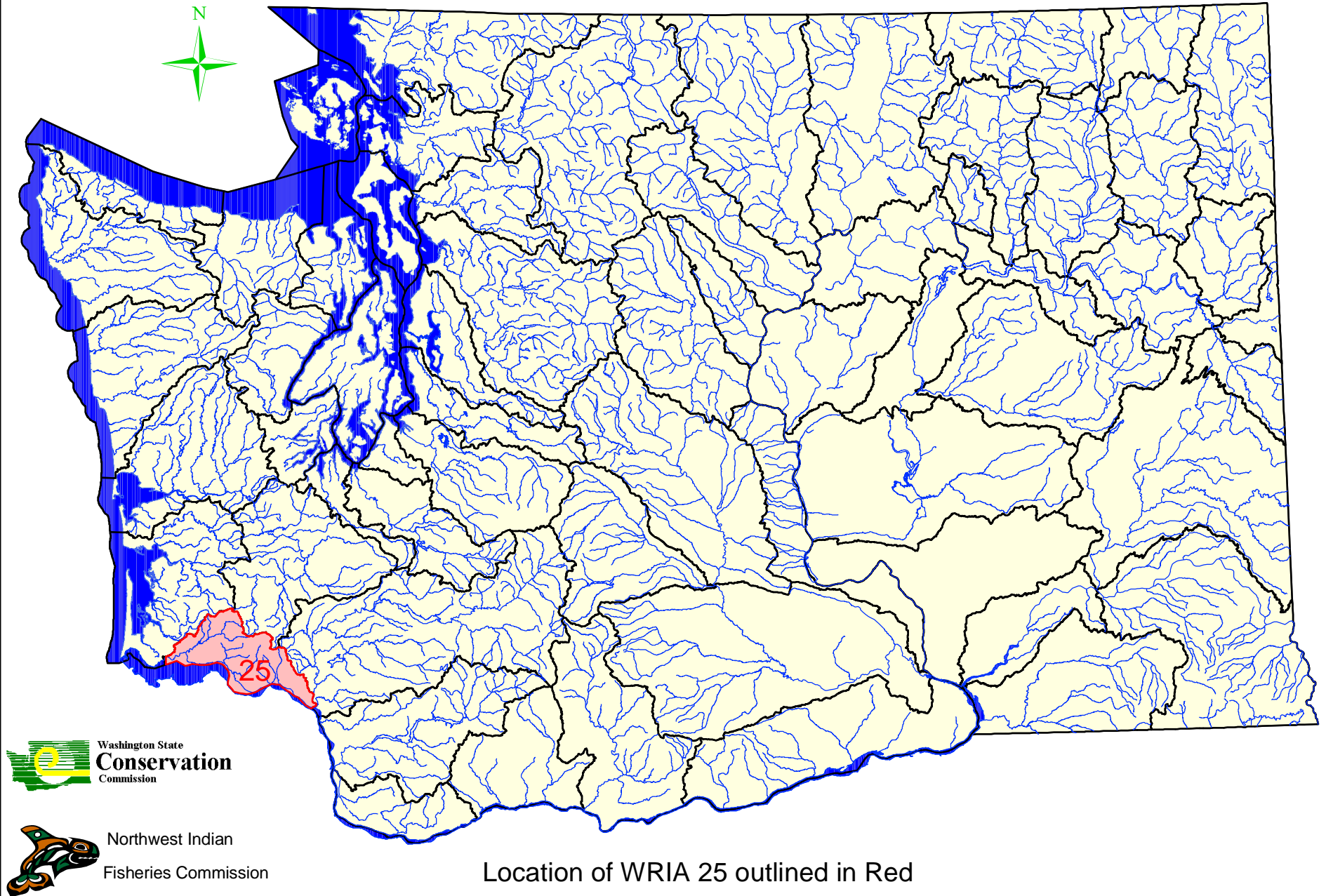
#### Description

Water Resource Inventory Area (WRIA) 25 is located in Southwest Washington. The area encompasses 322,582 acres including all of Wahkiakum and portions of Cowlitz, Pacific, and Lewis counties (Figure 1). Located along the lower Columbia River, the majority of this watershed is within the Coast Range ecoregion. All of the streams within WRIA 25 are tributaries to the Columbia River. The report also includes information on all tributaries to the Columbia River in WRIA 24 including the Chinook and Wallicut Rivers.

#### Demographics

Department of Ecology provides the following summary information for WRIA 25 (WDOE 1999). Forestry is the dominant land use (83%) followed by Other (8%), Agriculture (5%) and Urban (4%). Ownership is predominantly Private (83%), followed by State (16%) then Federal (1%). The principal economic activity, derived from total wages, is Government (32%) followed by Manufacturing (23%), Retail trade (16%), Services (14%), Other (8%), and Agriculture/ Forestry (7%). There are approximately 62,000 people living in WRIA 25. Principal cities include Longview, Cathlamet, and Altoona. The primary population center is Longview although the majority of people live in unincorporated areas.

Figure 1 Location of WRIA 25



## Water Quality

There are a number of stream segments listed on the Department of Ecology's 303(d) list for water quality impaired water bodies in WRIA 25. These are presented in the following table (WDOE 1999):

**Table 1: Water Quality Impaired Streams**

Waterbody Name	Parameter	Township	Range	Section	New ID#	Old ID#
Grays River, West Fork	Temperature	11N	07W	33	OV80RL	WA-15-1015
Elochoman River	Temperature	09N	05W	15	RE01VV	WA-25-3010
Abernathy Creek	Temperature	9N	4W	09	AP47TF	WA-25-3300
Germany Creek	Temperature	09N	03W	06	OF50GD	WA-25-3500
Longview Ditches	Dissolved Oxygen	07N	02W	03	FQ06HT	WA-25-5010
Longview Ditches	Dissolved Oxygen	07N	02W	04	FQ06HT	WA-25-5010
Longview Ditches	Dissolved Oxygen	07N	02W	05	FQ06HT	WA-25-5010
Longview Ditches	Dissolved Oxygen	08N	02W	30	FQ06HT	WA-25-5010
Longview Ditches	Dissolved Oxygen	08N	02W	31	FQ06HT	WA-25-5010
Longview Ditches	Dissolved Oxygen	08N	02W	31	GG32VT	WA-25-5010
Longview Ditches	Fecal Coliform	07N	02W	03	FQ06HT	WA-25-5010
Longview Ditches	Fecal Coliform	07N	02W	03	FQ06HT	WA-25-5010
Longview Ditches	Lead	07N	02W	05	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	07N	02W	03	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	07N	02W	04	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	07N	02W	05	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	08N	02W	30	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	08N	02W	31	FQ06HT	WA-25-5010
Longview Ditches	Turbidity	08N	02W	31	GG32VT	WA-25-5010
Sacajawea Lake	4,4'-DDE	08N	02W	33	837NAY	WA-25-9010
Sacajawea Lake	Chlordane	08N	02W	33	837NAY	WA-25-9010
Sacajawea Lake	Dieldrin	08N	02W	32	837NAY	WA-25-9010
Sacajawea Lake	PCB-1254	08N	02W	33	837NAY	WA-25-9010
Sacajawea Lake	PCB-1260	08N	02W	33	837NAY	WA-25-9010

In a watershed briefing paper for the Lower Columbia Basin Watershed, Department of Ecology (Ehinger et. al., 1996) identified water quality problems in a number of areas including; in the Longview ditches, potential water quality impacts from dairy operations, aluminum toxicity in Mill and Cameron Creeks, and invasive aquatic plants, and water quality in the streams listed on the 303(d) list. The report provides recommendations to address these concerns including:

- “Recommendations of watershed assessment work for the Longview ditches should be considered to address water quality concerns”
- “Further studies of the contributions of dairies and potential effectiveness of Best Management Practices are warranted to address fecal coliform contamination in the Water Quality Management Area.”
- “Follow-up on aluminum toxicity in Mill and Cameron Creeks. Study should be fine-tuned to address the possibility that aluminum is causing acute toxicity on these creeks. WDFW should be consulted on their level of interest and whether or not other creeks may be affected.”
- “Invasive aquatic plants have been noted in numerous locations. Identification of unimpacted water bodies would allow a preventive strategy. Extensive survey of water bodies is the first step.”
- Continue river and marine water quality monitoring through coordinated efforts. Baseline information for lakes would be helpful for future reference.

#### Water Quantity

United States Department of Geological Survey is the principal source of streamflow data for WRIA 25. The following table provides a list of active and inactive stage gaging stations in WRIA 25 (USGS 1984).

**Table 2: Discontinued surface-water discharge or stage-only stations**

Station Name	Station Number	Period of Record (water years)
Grays River above S.Fk. Grays River, WA	14249000	1956-75
Grays River below S.Fk. Grays River, WA	14249500	1956-60
Grays River near Grays River, WA	14250000	1949-51
West Fork Grays River near Grays River, WA	14250500	1949-69
Hull Creek at Grays River, WA	14251000	1949
Jim Crow Creek near Grays Harbor, WA	14248200	1964-74
Skamokawa Creek near Skamokawa, WA	14248000	1949-50
Elochoman River near Cathlamet, WA	14247500	1941-71
Germany Creek near Longview, WA	14245500	1949
Abernathy Creek near Longview, WA	14246000	1949-58
Mill Creek near Cathlamet, WA	14246500	1949-56

**Table 3: Discontinued surface-water quality stations**

Station Name	Station Number	Type of Record	Period of Record (water years)
Abernathy Creek near Longview, WA	14246000	Temperature	1950;1953-57
Mill Creek near Cathlamet, WA	14246500	Temperature	1954
Elochoman River near Cathlamet, WA	14247500	Temperature	195

Department of Ecology has utilized USGS data to evaluate groundwater contribution to baseflow at active and inactive stations located on several streams in WRIA 25 including Mill Creek, Abernathy Creek, Germany Creek, and the Elochoman River (Sinclair and Pitz 1999).

Local efforts are underway as a component of the Water Resource Inventory Area 25 planning effort to identify surface water and groundwater withdrawals and evaluate their effect on instream flows. This planning effort is part of the statewide watershed planning effort sponsored under House Bill 2514.

Lewis County GIS (2000) used data from Lunetta et al. (1997) to assess the likelihood of land management affects on peakflow. The information was compiled by watershed administrative units (WAU's). Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000).

**Table 4: Peakflow Impaired Subwatersheds**

Subbasin	Watershed Administrative Unit Name	Affect on Peakflow
Grays Bay	Grays Bay	Impaired
Grays Bay	Main Fork	Impaired
Grays Bay	South Fork	Likely Impaired
Grays Bay	Mitchell Creek	Impaired
Skamokawa-Elochoman	Skamokawa	Impaired
Skamokawa-Elochoman	Main Elochoman	Impaired
Skamokawa-Elochoman	North Elochoman	Likely Impaired
Germany-Abernathy	Abernathy	Impaired
Germany-Abernathy	Germany	Impaired
Germany-Abernathy	Coal Creek	Impaired

Lewis County GIS 2000

The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover

was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. The results of this effort are provided in the following table.

### Threatened and Endangered Species

Table 5 provides a list of fisheries listed as threatened or endangered for WRIA 25 (NOAA 2001).

**Table 5: Threatened or Endangered listing status of anadromous salmonids**

<b>Species</b>	<b>Listing Status</b>	<b>Date of Listing</b>
Chinook Salmon	Threatened	March 24, 1999
Chum Salmon	Threatened	March 25, 1999
Coastal Cutthroat Trout	Proposed-Threatened	April 5, 1999
Coho Salmon	Candidate Species for Listing	July 25, 1995

In addition to anadromous salmonids, several species of plants and wildlife are identified as threatened or endangered species. Some sources for information regarding threatened and endangered plants and animals include the federally listed species maintained by the United States Fish and Wildlife Service, Priority Species and Habitats listings maintained by the Washington Department of Fish and Wildlife, and the Heritage database maintained by the Department of Natural Resources.

### Landuse

Land use varies by watershed but typically follows similar patterns. Agriculture and rural residential use is predominantly located on alluvial deposits in the lower watershed. Residential use is increasing on upland soils. Non-industrial woodlands are located in the lower third of most watersheds. Industrial forestland is the dominant use in the upper watersheds (WCD 2001). Land use in WRIA 25 is predominantly industrial forestland. Table 6 provides the percent area in several land use categories for the major watersheds within the subbasins of WRIA 25. The information is derived from aerial photograph interpretation and County tax lot maps (CCD/WCD 2001).

Forestland in the Chinook-Grays and Skamokawa-Elochoman subbasins was delineated into industrial and non-industrial ownership. The “Other” category is predominantly wetlands, power line right of way, or hatcheries.

**Table 6: Land Use (percent of area in watershed)**

Watershed / Subbasin	Agriculture (% of area)	Forestland		Rural Residential (% of area)	Urban (% of area)	Other (% of area)
		Non-Industrial (% of area)	Industrial (% of area)			
Deep River	5.9	33.9	46.2	14.0	0.0	0.0
Grays River	3.4	19.1	73.3	4.2	0.0	0.0
<b>Chinook-Grays Subbasin</b>	<b>3.6</b>	<b>20.4</b>	<b>71.0</b>	<b>5.0</b>	<b>0.0</b>	<b>0.0</b>
Jim Crow Creek	0.0	1.3	97.0	0.0	0.0	1.7
Skamokawa Creek	11.5	9.4	78.8	0.2	0.0	0.0
Elochoman River	3.8	11.3	81.6	0.0	0.0	3.4
<b>Skamokawa – Elochoman Subbasin</b>	<b>6.4</b>	<b>10.1</b>	<b>81.3</b>	<b>0.1</b>	<b>0.0</b>	<b>2.1</b>
Mill Creek	3.1	8.1	88.7	0.1	0.0	0.0
Abernathy Creek	0.7	0.0	99.2	0.1	0.0	0.0
Germany Creek	2.2	0.0	97.8	0.0	0.0	0.0
Coal Creek	4.2	0.0	93.1	1.8	0.0	0.9
Clark Creek	0.0	0.0	70.8	29.2	0.0	0.0
<b>Germany - Abernathy Subbasin</b>	<b>2.4</b>	<b>2.1</b>	<b>93.5</b>	<b>1.7</b>	<b>0.0</b>	<b>0.2</b>
<b>WRIA 25</b>	<b>4.3</b>	<b>11.7</b>	<b>80.9</b>	<b>2.4</b>	<b>0</b>	<b>0.7</b>

Data from CCD/WCD 2001

### Topography

The watersheds in WRIS 25 contain coastal headlands and upland terraces and are characterized by low rolling hills and undulating glacial drift plains. Three major topographic features occur in WRIA 25 including:

- The rugged area of the Willapa Hills which occupy a major portion of the Grays-Chinook and Elochoman-Skamokawa subbasin;
- The valley plains along the Columbia River, and;
- The rolling hill topography of the Willapa Hills that occurs in Germany-Abernathy subbasin.

Table 7 provides a comparison of minimum elevation, maximum elevation, average elevation and average slope for the major watersheds within the subbasins. The tabled data was developed as part of a watershed characterization project conducted by Cowlitz and Wahkiakum Conservation Districts (CCD/WCD 2001).

**Table 7: Topographic Characterization**

Watershed / Subbasin Name	Average Slope (%)	Maximum Elevation (feet)	Minimum Elevation (feet)	Average Elevation (feet)
Deep River	13.6	1000	5	291
Grays River	24.3	2840	5	948
<b>Chinook-Grays River Subbasin</b>	<b>23.4</b>	<b>2840</b>	<b>5</b>	<b>891</b>
Jim Crow Creek	20.3	1480	5	490
Skamokawa Creek	25.2	2600	5	570
Elochoman River	23.7	2673	5	883
<b>Skamokawa-Elochoman Subbasin</b>	<b>24.1</b>	<b>2673</b>	<b>5</b>	<b>748</b>
Mill Creek	13.6	1840	20	856
Abernathy Creek	26.4	2600	20	962
Germany Creek	25.9	2600	20	1200
Coal Creek	18.8	2280	10	829
Clark Creek	21.5	960	19	478
<b>Germany-Abernathy Subbasin</b>	<b>20.9</b>	<b>2600</b>	<b>10</b>	<b>931</b>
<b>WRIA 25</b>	<b>22.9</b>	<b>2840</b>	<b>5</b>	<b>852</b>

### Climate

Water Resource Inventory Area 25 has “a mid-latitude, west cost marine climate”. Summers are comparatively dry and cool and winters are mild, wet, and cloudy. Variations in the elevations and exposure to the prevailing direction of the wind result in a wide range of climatic conditions within short distances. Mean temperature ranges from 31-46° in the winter to 50-76° in the summer. The diurnal range in temperature varies from approximately 15° C in winter to 25° C in summer (Phillips, 1964). Annual precipitation ranges from 45 inches in the Longview area to 120 inches in the Upper Grays River watershed. Snowfall is generally light and transient in nature. Table 8 provides a comparison of minimum, maximum, and mean annual precipitation for the major watersheds within the subbasins of WRIA 25.

Washington State Department of Natural Resources recognizes five climate zones including lowlands, rain dominated, rain on snow, snow dominated, and highlands. These zones begin to provide an indication of how a watershed is expected to respond during winter runoff. Rain-on-snow zones are particularly important because the conditions in these areas have the capability to significantly affect the hydrograph during a storm event. The rain on snow zone is a transient snow zone. Temperatures can readily drop resulting in snow accumulation that is stored water. During subsequent storm events temperatures and the heat within rainfall itself can release this stored water resulting in a significant increase in storm runoff. The percent area in each of these five climate zones is provided for each of the major watersheds within the subbasins in Table 9

**Table 8: Precipitation Characterization**

Watershed / Subbasin Name	Minimum Mean Annual Precipitation (in inches)	Maximum Mean Annual Precipitation (in inches)	Average Mean Annual Precipitation (in inches)
Deep River	65	90	81.6
Grays River	60	120	88.3
<b>Chinook-Grays River Subbasin</b>	<b>60</b>	<b>120</b>	<b>87.8</b>
Jim Crow Creek	60	80	72.0
Skamokawa Creek	60	95	78.1
Elochoman River	45	118	86.7
<b>Skamokawa-Elochoman Subbasin</b>	<b>45</b>	<b>118</b>	<b>82.8</b>
Mill Creek	54	92	74.8
Abernathy Creek	54	100	72.6
Germany Creek	54	102	83.4
Coal Creek	47	76	56.3
Clark Creek	45	48	46.3
<b>Germany-Abernathy Subbasin</b>	<b>45</b>	<b>102</b>	<b>70.4</b>
<b>WRIA 25</b>	<b>45</b>	<b>120</b>	<b>81.2</b>

**Table 9: Climatic Zone Characterization (percent of watershed area)**

Watershed / Subbasin	Lowlands	Rain Dominated	Rain on Snow	Snow Dominated	Highlands
Deep River	48.2	51.8	0.0	0.0	0.0
Grays River	36.6	62.4	1.0	0.0	0.0
<b>Chinook-Grays Subbasin</b>	<b>37.6</b>	<b>61.5</b>	<b>0.9</b>	<b>0.0</b>	<b>0.0</b>
Jim Crow Creek	96.0	4.0	0.0	0.0	0.0
Skamokawa Creek	79.1	20.1	0.6	0.2	0.0
Elochoman River	16.6	73.6	9.8	0.0	0.0
<b>Skamokawa-Elochoman Subbasin</b>	<b>43.2</b>	<b>50.8</b>	<b>6.0</b>	<b>0.1</b>	<b>0.0</b>
Mill Creek	0.0	99.1	0.9	0.0	0.0
Abernathy Creek	0.0	94.2	5.8	0.0	0.0
Germany Creek	0.0	73.4	26.7	0.0	0.0
Coal Creek	0.0	96.1	3.9	0.0	0.0
Clark Creek	0.0	100.0	0.0	0.0	0.0
<b>Germany-Abernathy Subbasin</b>	<b>0.0</b>	<b>91.9</b>	<b>8.1</b>	<b>0.0</b>	<b>0.0</b>
<b>WRIA 25</b>	<b>29.18</b>	<b>66.14</b>	<b>4.66</b>	<b>0.02</b>	<b>0</b>

As Table 9 shows, only the Germany Creek watershed has a substantial percentage of its area dominated by rain-on-snow zones.

## Geology

Geology greatly influences the development of soils, slope stability, and dictates the competence of the rock that becomes the typical substrate for the streams within a watershed. The geology in WRIA 25 tends to shift from volcanic origin in the eastern watersheds to mix of sedimentary and volcanic sediments in the western watersheds. Although it does not provide a complete picture of the geologic strata within the watershed, Table 10 provides a basic indication of the surface geology in the major watersheds within each of the subbasin.

**Table 10: Geologic Characterization**

Watershed /Subbasin Name	Unconsolidated	Intrusive	Sedimentary	Volcanic
Deep River	30.0	0.0	70.0	0.0
Grays River	7.9	8.7	48.7	34.6
<b>Chinook-Grays Subbasin</b>	<b>9.8</b>	<b>8.0</b>	<b>50.6</b>	<b>31.6</b>
Jim Crow Creek	2.3	0.0	94.6	3.1
Skamokawa Creek	19.0	0.0	74.4	6.6
Elochoman River	13.4	3.0	43.5	40.1
<b>Skamokawa-Elochoman Subbasin</b>	<b>14.9</b>	<b>1.7</b>	<b>57.2</b>	<b>26.1</b>
Mill Creek	0.7	0.0	0.0	99.3
Abernathy Creek	0.0	5.3	0.0	94.7
Germany Creek	1.4	0.0	26.4	72.3
Coal Creek	1.8	0.0	21.0	77.2
Clark Creek	0.0	0.0	64.2	35.8
<b>Germany-Abernathy Subbasin</b>	<b>0.9</b>	<b>1.4</b>	<b>13.0</b>	<b>84.8</b>
<b>WRIA 25</b>	<b>9.2</b>	<b>3.9</b>	<b>42.5</b>	<b>44.4</b>

Data from CCD/WCD 2001

## Soils

General soils associations identified in the USDA Soil Surveys for Wahkiakum County (1986) and Cowlitz County (1974) were used to obtain a general overview of the watersheds. The general soils represent broad areas that have a distinctive pattern of soils relief, and drainage. They can be used to compare broad areas. For planning purposes, the site-specific soil series should be referenced.

### *Wahkiakum County Soil Associations*

The following general soil descriptions have been adapted from the USDA soil surveys for the major watersheds in Water Resource Inventory Area 25, located predominantly within Wahkiakum County. These watersheds include Deep River, Grays River, Jim Crow Creek, Skamokawa Creek and the Elochoman River.

The “Ocasta” soil association consists of soils along coastal bays in the area. These are very deep, poorly drained soils formed in alluvium deposited in Coastal Bays. Ditching, tiling, and pumping practices have altered soil drainage. The surface is covered with a mat of sedge and grass leaves. The surface layer is silty clay loam. The underlying material to a depth of 60 inches or more is silty clay and clay. This soil is used mainly for hay, pasture, and crops and as habitat for open land and wetland wildlife. It is poorly suited to home site development or as woodland. The main limitation is the high water table.

The Grehalem-Rennie soil association consists of soils along drainageways throughout the area. The well-drained Grehalem soil formed in alluvium derived dominantly from basic igneous and sedimentary rock. The surface layer is silt loam. The underlying material to a depth of 60 inches or more is mainly silty clay loam. The poorly drained Rennie soils are in depression areas. They formed in alluvium derived dominantly from basic igneous and sedimentary rock. The surface layer is silty clay loam. The subsoil and substratum to a depth of 60 inches or more are silty clay and clay. These soils are used for hay, pasture, crops, wildlife habitat, woodland, and home sites. If the soils are used for home site development, the main limitations are the hazard of flooding and a seasonal high water table.

The Lytell-Astoria soil association consists of soils on broad low ridges and uneven side slopes. The deep Lytell soils are on slumps on uplands. They formed in colluvium derived dominantly from marine siltstone and fine-grained sandstone. Slope is 8-90 percent. The surface layer is silt loam. The subsoil is silty clay loam over siltstone, which is at a depth of about 50 inches. The very deep Astoria soils are on uplands. They formed in residuum derived dominantly from siltstone. Slope is 3-65 percent. The surface layer is silt loam. The subsoil is to a depth of 60 inches or more and is silty clay. These soils are used mainly as woodland, wildlife habitat, and recreation areas. It is also used for hay, pasture, and rural home sites. If this unit is used for home site development, the main limitations are steepness of slope and the hazard of sliding.

The Zenker-Elochoman soil association consists of soils on sharp ridges and long slopes. The Zenker soils formed in colluvium derived from marine sandstone. Slope is 8-90 percent. The surface layer is silt loam. The subsoil is dominantly loam to a depth of 60 inches or more. The Elochoman soils are on uplands. They formed in residuum derived from sandstone. The surface layer is silt loam. The subsoil is also silt loam to a depth of 60 inches or more. These soils are used mainly as woodland, wildlife habitat, and recreation areas. It is also used for rural home sites. If this unit is used for home site development, the main limitations are steepness of slope and the hazard of sliding.

The Raught-Germany soil association consists of soils on uplands. The Raught soils are on shoulders and back slopes on uplands. Slope is 5-90 percent. The Germany soils are on plateaus, shoulders, and back slopes on uplands. Slope is 1-65 percent. These soils form in residuum and colluvium derived mainly from basic igneous rocks. The surface layer is silt loam and the subsoil is silt loam to a depth of 60 inches or more. These soils

are used mainly as woodland and wildlife habitat. It is also used for hay, pasture, and rural home sites. If this unit is used for home site development, the main limitation is steepness of slope.

The Bunker-Knappton soil association consists of soils on side slopes on uplands. Bunker soils have slopes of 5-90 percent. Knappton soils have slope of 8-90 percent. The soils formed in colluvium derived mainly from basic igneous rocks. The Bunker soils surface layer is silt loam and the subsoil is gravelly silt loam. Basalt is at a depth of about 50 inches. The Knappton soils surface layer is silt loam. The subsoil is gravelly silty clay loam. Basalt is at a depth of about 43 inches. This unit is used as woodland and wildlife habitat. It is well suited as woodland.

The Lates-Murnen soil association consists of soils on mountains. The moderately deep Lates soil formed in residuum derived mainly from basic igneous rocks. Slope is 8-90 percent. The surface layer is silt loam and the subsoil is gravelly loam. Basalt is at a depth of 35 inches. The very deep Murnen soil formed in residuum derived mainly from basic igneous rocks. Slope is 5-65 percent. The soils are silt loam to a depth of 60 inches or more. This unit is used as woodland and wildlife habitat. It is well suited as woodland.

#### *Cowlitz County Soil Associations*

The following general soils descriptions have been adapted from the USDA soil surveys for the major watersheds in WRIA 25 located predominantly within Cowlitz County. These watersheds include Mill, Abernathy, Germany, Coal, and Clark Creek watersheds.

The “Germany-Olympic” soil association is about 70 percent Germany soils and 25 percent Olympic soils. The remaining acreage is Olequa and Camas soils, Clato soils, coarse variant, and rock outcrop. The gently sloping Germany and Olympic soils are on ridgetops, and the steep to very steep Germany and Olympic soils are on the hillsides and mountainsides. The gently sloping Olequa soils are on hillsides and broad ridges at higher elevations. The nearly level Clato and Camas soils are on flood plains.

The well-drained Germany soils formed in very deep, wind-laid deposits. They have a surface layer of dark-brown silt loam and a subsoil of brown heavy silt loam. Depth to basalt bedrock is more than 6 feet in most places.

The well-drained Olympic soils formed in weathered basalt and andesite. They have a surface layer of dark-brown silt loam and a subsoil of dark reddish-brown and dark-brown silt loam and silty clay loam. Depth to basalt or andesite is more than 6 feet in most places.

Most of this soil association is coniferous forest. Douglas fir grows faster in this association than in any other part of the Cowlitz County soil survey area. Small areas have been cleared, mainly along the streams and on the broad gently sloping ridges. Hay and pasture are the principal crops. Beef and Dairy farms are the principal farm enterprises.

The Bear Prairie-Loper association consists of soils formed mainly in residuum derived from basalt, andesite, and sandstone. Ridges that formed in andesite and basalt have gently sloping sides and moderately broad tops. The ridges that formed in sandstone are sharp, narrow, and strongly sloping and the drainageways have short, stubby, lateral branches. The narrow valleys have deeply entrenched, swiftly flowing perennial and intermittent streams. Rock outcrops and cobblestones are common.

The association is about 60 percent Bear Prairie soils, 30 percent Loper soils, 9 percent Vader soils and 1 percent rock land. The gently sloping Bear Prairie and Loper soils are on moderately broad ridges and hillsides, and the steep Bear Prairie and Loper soils are on mountainsides. Many of the steep soils are eroded. The strongly sloping Vader soils are on narrow ridges and the steep Vader soils are on mountainsides. Many of the steep soils are eroded. There are small patches of rock land throughout the association.

The well-drained Bear Prairie soils formed mainly in weathered basalt and andesite. The surface layer is very dark brown and very dark grayish-brown silt loam, and the subsoil is dark-brown silt loam. Bedrock is at a depth of more than 5 feet.

The well-drained Loper soils formed in weathered basalt and andesite. The surface layer is very dark brown cobbly silt loam, and the subsoil is dark-brown gravelly silt loam and very gravelly silt loam. The depth to bedrock ranges from 2.5 to more than 5 feet.

Most of this association is forested and is used mainly for timber production and wildlife habitat. The vegetation is mostly Douglas fir and smaller stands of western hemlock, red alder, western red cedar, silver fir and bigleaf maple.

The “Caples-Clato-Newberg” association is mainly on flood plains. It is about 35 percent Caples soils, 25 percent Clato soils, 20 percent Newberg soils, 10 percent Pilchuck soils, 3 percent Newberg Silty Variant, 3 percent Snohomish soils, and 4 percent Godfrey and other soils.

The somewhat poorly drained and poorly drained nearly level Caples soils are in smooth slightly concave areas. The surface layer, in most places, is dark-brown silt loam and silty clay loam, and the subsoil is mottled gray and grayish-brown silty clay loam.

The nearly level, well-drained Clato soils are on flood plains. The surface layer is dark yellowish-brown and dark-brown silt loam. Below this is dark yellowish-brown, heavy silt loam. Below a depth of 42 inches, the substratum is sandy in some places.

Newberg soils are nearly level to slightly undulating and have smooth convex slopes. They are well drained and have a surface layer of very dark-grayish-brown fine sandy loam. Below this are very dark grayish-brown and dark-brown, stratified fine sandy loam, silt loam, and loamy sand.

Most of this association has been cleared and is either farmed or used for industrial urban development. The scattered trees that remain are red alder, bigleaf maple, black cottonwood, Douglas fir, western red cedar, Oregon ash, and willow. Hay and pasture are the principal crops but small grain, strawberries, cane fruits, potatoes, carrots, bulbs, cabbage, mint, sweetcorn, field corn, broccoli, peas and green beans are also grown. The principal farming area in the Cowlitz Area is on this association. Farms range from a few acres to about 400 acres in size. The average size is 180 acres.

Table 11 and Table 12 provide the percent watershed area in these general soil associations for each of the major watershed within the subbasins.

**Table 11: Wahkiakum County Soil Associations (percent of watershed area)**

Watershed / SubbasinName	Ocasta Soils	Grehalem - Rennie Soils	Chehalis - Skamo - Spanaway Sils	Lytell-Astoria Soils	Zenker-Elochoman Soils	Raught - Germany Soils	Bunker - Knappton Soils	Lates - Murnen Soils
Deep River	19.0	3.0	0.0	76.4	0.0	0.0	1.6	0.0
Grays River	3.5	2.9	0.0	43.2	2.9	0.1	35.9	11.5
<b>Chinook – Grays Subbasin</b>	<b>4.9</b>	<b>2.9</b>	<b>0.0</b>	<b>46.1</b>	<b>2.6</b>	<b>0.1</b>	<b>32.9</b>	<b>10.5</b>
Jim Crow Creek	1.9	1.5	0.0	86.2	7.7	0	2.7	0
Skamokawa Creek	3.1	6.2	0.1	37.5	36.5	0.2	15.6	0.8
Elochoman River	5.9	3.8	0	9.3	22.0	22.8	32.4	3.8
<b>Skamokawa – Elochoman Subbasin</b>	<b>4.7</b>	<b>4.5</b>	<b>0.2</b>	<b>23.4</b>	<b>26.5</b>	<b>13.4</b>	<b>24.8</b>	<b>2.5</b>

Cowlitz/Wahkiakum Conservation District data

**Table 12: Cowlitz County Soil Associations**

Watershed /Subbasin Name	Germany – Olympic Soils	Bear Prairie – Loper Soils	Olympic – Olequa Soils
Mill Creek	95.5	4.5	0
Abernathy Creek	77.2	22.3	.5
Germany Creek	66.1	33.8	0.1
Coal Creek	98.1	1.5	0.4
Clark Creek	99.4	0	0.6
<b>Germany-Abernathy Subbasin</b>	<b>853.5</b>	<b>14.2</b>	<b>0.3</b>

Cowlitz/Wahkiakum Conservation District data

United States Department of Agriculture, Natural Resources Conservation Service soil surveys were consulted to obtain slopes and k factors for the various soil series to

estimate soil erodibility with the watersheds. These values were applied to Washington State Watershed Analysis surface erosion procedures for erodibility classes in Table 13.

**Table 13: Soil Erodibility Classes**

	Soil K Factor		
Slope (percent)	<0.25	0.25-0.40	>0.40
<=30	Low	Low	Moderate
30-65	Low	High	High
>65	Moderate	High	High

Table 14 provides the percent area in each of these erosion classes for the major watersheds within each subbasin. For the majority of the area in WRIA 25, soil erodibility is low (70%). The Grays and Elochoman Rivers and Abernathy Creek have the highest percentage of highly erodible soils of all the watersheds in WRIA 25.

**Table 14: Soil Erodibility Characterization (percent of watershed area)**

Watershed / Subbasin Name	Low	Moderate	High	NA
Deep River	86.9	2.2	10.9	0.0
Grays River	69.6	4.4	26.0	0.0
<b>Chinook - Grays Subbasin</b>	<b>71.1</b>	<b>4.2</b>	<b>24.7</b>	<b>0.0</b>
Jim Crow Creek	93.5	4.9	1.5	0.0
Skamokawa Creek	67.0	22.7	10.3	0.0
Elochoman River	54.9	13.9	28.0	3.2
<b>Skamokawa - Elochoman Subbasin</b>	<b>61.2</b>	<b>16.7</b>	<b>20.2</b>	<b>1.9</b>
Mill Creek	87.6	0.0	12.4	0.0
Abernathy Creek	62.4	8.1	29.1	0.4
Germany Creek	77.2	0.3	22.5	0.0
Coal Creek	91.2	0.5	8.3	0.0
Clark Creek	88.7	0.0	11.3	0.0
<b>Germany - Abernathy Subbasin</b>	<b>79.9</b>	<b>2.3</b>	<b>17.7</b>	<b>0.1</b>
<b>WRIA 25</b>	<b>70.1</b>	<b>8.0</b>	<b>21.2</b>	<b>0.7</b>

### Road Condition

Table 15 provides a summary of road information from a data set developed by the U.S. Environmental Protection Agency (EPA) Region 10, Seattle, Washington (see Lunetta et al. 1997 for a complete description of this data). This data was organized by Watershed Administrative Unit (WAU) and has been adapted to correspond to the major watershed divisions employed during the development of this limiting factors analysis. Roads within 200 feet of anadromous streams were defined as within the riparian buffer.

The Longview/Clark Creek WAU has the highest road density and a high percentage of its roads are located within 200 feet of anadromous streams. Germany Creek and the Grays River areas have the largest number of stream crossings per square mile, as well as high road densities.

**Table 15: Road Characterization**

Watershed / Subbasin Name	Percent of Roads in the Riparian Buffer (within 200 feet of anadromous streams)	Stream Crossings (Crossings per Square Mile)	Road Density (Miles per Square Mile)
Grays River / Deep River	8.9	27.3	4.4
<b>Chinook – Grays Subbasin</b>	<b>8.9</b>	<b>27.3</b>	<b>4.4</b>
Skamokawa Creek / Jim Crow / Alger Creek / Birnie Creek	11.0	13.3	3.9
Elochoman River	12.4	15.9	3.3
<b>Skamokawa-Elochoman Subbasin</b>	<b>11.7</b>	<b>14.6</b>	<b>3.6</b>
Abernathy Creek and Mill Creek	11.2	12.6	4.2
Germany Creek	11.1	31.7	5.8
Coal Creek	16.1	18.7	5.2
Longview / Clark Creek	12.7	5.7	7.9
<b>Germany-Abernathy Subbasin</b>	<b>12.8</b>	<b>17.2</b>	<b>5.8</b>
<b>WRIA 25</b>	<b>11.9</b>	<b>17.9</b>	<b>5.0</b>

Data from Lunetta et al. 1997 and Lewis County GIS 2000

### Land Cover

Potential natural vegetation in WRIA 25 includes western hemlock, western red cedar, Sitka spruce, and Douglas fir. Lunetta et al. (1997) developed a GIS coverage on land cover using data from 1988 Landsat 5 Thematic Mapper (TM), updated with 1991 and 1993 harvest data.

Table 16 details how forest cover was classified. Forest cover was broadly categorized into four forest classes based on forest type and age class. The overall thematic accuracy of the 1988 TM-based land-cover categorization was 92 percent (PMR 1993 as cited in Lunetta et al. 1997). The non-forest land cover and most surface water features were derived from 1:250,000-scale U.S. Geological Survey land-cover/land-use data. For more information on how this data was collected and used (see Lunetta et al. 1997).

Table 17 provides the number of acres in land cover category and the percent of the total acres in WRIA 25. In WRIA 25, the land cover category with the greatest number and percentage of acres is the “Other” category (Less than 10% coniferous crown cover (can contain hardwood tree/scrub cover; cleared forest land; etc.). Mid seral stage vegetation covers the second greatest number of acres.

**Table 16: Land Cover Categories Derived from Landsat 5 TM data (PMR 1993 and WDNR 1994).**

<b>Land Cover Category</b>	<b>Description</b>
Class 1: Late Seral Stage	Coniferous crown cover >70%. More than 10% crown cover in trees =21 inches in diameter breast height (dbh)
Class 2: Mid-Seral Stage	Coniferous crown cover >70%. Less than 10% crown cover in trees =21 inches dbh
Class 3: Early Seral Stage	Coniferous crown cover =10% to 70%. Less than 75% of total crown cover in hardwood tree/scrub cover.
Class 4: Other Land in Forested Areas	Less than 10% coniferous crown cover (can contain hardwood tree/scrub cover; cleared forest land; etc.
Class 5: Surface Water	Lakes, large rivers, and other water bodies
Class 15: Non-Forest Lands	Urban, agriculture, rangeland, barren, and glaciers

Adapted from Lunetta et al. 1997.

**Table 17: WRIA 25 Land Cover**

<b>WRIA 25</b>	<b>Late Seral</b>	<b>Mid Seral</b>	<b>Early Seral</b>	<b>Other</b>	<b>Water</b>	<b>Non-Forest</b>	<b>Sum</b>
<b>Acres</b>	1,384	88,689	36,997	141,482	21,047	32,716	<i>322,315</i>
<b>Percent</b>	0.4	27.5	11.5	43.9	6.5	10.2	<i>100</i>

Data from Lunetta et al. 1997

## **DISTRIBUTION AND CONDITION OF STOCK**

The distribution of fall chinook salmon, coho salmon, chum salmon, and winter steelhead, was mapped within tributaries to the Columbia River in WRIA 24 and in WRIA 25 at a 1:24,000 scale for this Habitat Limiting Factors Analysis. Maps for each anadromous species of interest were developed using a number of existing sources on distribution including the Salmon and Steelhead Stock Inventory (SASSI) (WDF et al. 1993), StreamNet, WDFW stream surveys, and WDFW spawning surveys (see Map Appendix for distribution maps). Members of the WRIA 24 and 25 Technical Advisory Groups (TAG) added considerable information to this process through their personal and professional experience with WRIA 25 stream systems. For each species, known, presumed, and potential habitat was mapped (see Appendix C: Fish Distribution Definitions).

Table 18 represents a compilation of all the fish distribution data that were collected for each stream and the number of miles of stream affected by physical barriers. Table 19 displays the same information summarized by subbasin.

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	<i>FC</i>	<i>Ch</i>	<i>Co</i>	<i>WS</i>	<i>Known</i>	<i>Pre.</i>	<i>Pot.</i>	<i>Total</i>	<i>Puncheon</i>	<i>Fishway</i>	<i>Gate</i>	<i>Weir</i>	<i>Inlet</i>	<i>Culverts</i>	
<b>WRIA 24</b>															
<b>Chinook Subbasin</b>															
<b>Chinook River</b>	X	X	X	X	5.65	0.00	0.00	5.65	0.00	0.00	0.00	0.00	0.00	0.00	
Kallstrom Creek				X	3.20	0.00	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	
Chinook River Trib.			X		0.28	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	*
Chinook River Trib.			X		0.64	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	*
Freshwater Creek			X	X	0.82	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	
Freshwater Creek Trib.			X		0.36	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	*
N. Fk. Freshwater Creek				X	0.98	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	
S. Fk. Freshwater Creek.				X	1.21	0.15	0.33	1.70	0.00	0.00	0.00	0.00	0.33	0.00	
S. Fk Freshwater Trib.				X	0.52	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	
South Branch Chinook R.			X	X	0.45	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	
Chinook River Trib.				X	0.26	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	
Right Branch Chinook R.				X	0.29	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	
Left Branch Chinook R.				X	0.41	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	
Columbia River Trib A			X		0.60	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	*
Columbia River Trib B			X		1.05	0.00	0.00	1.05	0.00	0.00	0.00	0.00	0.00	0.00	*

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	<i>FC</i>	<i>Ch</i>	<i>Co</i>	<i>WS</i>	<i>Known</i>	<i>Pre.</i>	<i>Pot.</i>	<i>Total</i>	<i>Puncheon</i>	<i>Fishway</i>	<i>Gate</i>	<i>Weir</i>	<i>Inlet</i>	<i>Culverts</i>	
<b>WRIA 25</b>															
<b>Grays Subbasin</b>															
Sisson Creek	X	X	X	X	1.02	1.22	0.00	2.24	0.00	0.00	0.00	0.00	0.00	0.00	*
<b>Deep River</b>	X	X	X	X	7.18	1.13	0.00	8.31	0.00	0.00	0.00	0.00	0.00	0.00	*
Campbell Creek (0076)			X	X	0.00	2.14	0.00	2.14	0.00	0.00	0.00	0.00	0.00	0.00	*
Lassila Creek (0077)			X	X	0.00	0.92	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	*
Salme Creek (0083)			X	X	0.00	0.71	0.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	*
Hendrickson Creek (0088)			X	X	0.56	0.70	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.00	*
Person Creek (0090)	X	X	X	X	2.25	0.00	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.00	*
<b>Grays River (0093)</b>	X	X	X	X	25.18	3.87	0.00	29.04	0.00	0.00	0.00	0.00	0.00	0.00	
Seal Slough (0102)			X	X	0.00	1.36	0.00	1.36	0.00	0.00	0.00	0.00	0.00	0.00	
Seal Creek (0104)			X	X	0.00	0.81	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
Malone Creek (0106)			X	X	0.00	3.81	0.00	3.81	0.00	0.00	0.00	0.00	0.00	0.00	
Grays River Trib. A		X	X		0.00	0.57	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	*
Grays River Trib. B		X	X		0.00	0.51	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	*
Impie Creek (0114)		X	X	X	0.00	0.03	1.74	1.77	0.00	0.00	1.74	0.00	0.00	0.00	*
Nikka Creek (0115)		X	X	X	0.00	0.50	0.09	0.59	0.00	0.00	0.00	0.00	0.00	0.09	
Thadbar Creek (0116)		X	X	X	0.00	0.09	1.08	1.17	0.00	0.00	0.00	0.00	0.00	1.08	
Kessel Creek (0118)		X	X	X	0.00	0.57	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	
Hull Creek (0119)	X	X	X	X	2.97	1.56	1.01	5.54	0.00	1.01	0.00	0.00	0.00	0.00	
Silver Creek (0120)			X		0.00	0.24	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	*
Honey Creek (0121)			X	X	0.00	0.76	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	*
Fall Creek (0122)			X		0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	*
Hull Creek Trib. (0123)			X	X	0.00	1.33	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	FC	Ch	Co	WS	Known	Pre.	Pot.	Total	Puncheon	Fishway	Gate	Weir	Inlet	Culverts	
King Creek (0126)			X		0.71	0.00	0.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	*
Klints Creek (0128)	X		X	X	0.00	3.33	0.00	3.33	0.00	0.00	0.00	0.00	0.00	0.00	
Fossil Creek (0130)	X		X	X	4.11	0.58	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00	*
West Fork Grays Riv. (0131)	X	X	X	X	4.20	1.76	0.00	5.96	0.00	0.00	0.00	0.00	0.00	0.00	
Shannon Creek (0132)			X	X	0.00	0.22	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	
W. Fk. Grays Trib. (0133)			X	X	0.00	0.65	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	
Beaver Creek (0134)			X	X	0.00	0.30	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	
Sneigiler Creek (0135)	X	X	X	X	0.00	1.68	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.00	
Crazy Johnson Creek (0139)		X	X		0.81	0.10	0.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00	*
South Fork Grays Riv. (0141)	X	X	X	X	6.21	3.36	0.00	9.57	0.00	0.00	0.00	0.00	0.00	0.00	
Blaney Creek (0142)			X	X	0.31	2.60	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	
Alder Creek (0155)			X	X	0.00	0.94	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	
Grays River Trib. (0156)			X	X	0.00	0.35	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	
East Fork Grays Riv (0157)	X		X	X	5.58	0.90	0.00	6.47	0.00	0.00	0.00	0.00	0.00	0.00	
E Fork Grays Trib. (---)			X	X	0.00	2.15	0.00	2.15	0.00	0.00	0.00	0.00	0.00	0.00	
Mitchell Creek (0159)			X	X	3.04	0.00	0.00	3.04	0.00	0.00	0.00	0.00	0.00	0.00	
Cabin Creek (0164)			X	X	0.00	0.65	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	
Johnson Creek (0165)			X	X	0.00	2.69	0.00	2.69	0.00	0.00	0.00	0.00	0.00	0.00	
Grays River Trib. (0168)			X	X	2.25	1.60	0.00	3.86	0.00	0.00	0.00	0.00	0.00	0.00	
Crooked Creek (0173)		X	X	X	0.00	5.58	0.00	5.58	0.00	0.00	0.00	0.00	0.00	0.00	
S Fork Crooked Cr (0175)			X	X	0.00	1.40	0.00	1.40	0.00	0.00	0.00	0.00	0.00	0.00	
<b>Elochomin/Skamokawa Subbasin</b>															
Jim Crow Creek (0187)		X	X	X	0.00	3.45	0.00	3.45	0.00	0.00	0.00	0.00	0.00	0.00	
Skamokawa Creek (0194)	X	X	X	X	6.80	0.00	0.00	6.80	0.00	0.00	0.00	0.00	0.00	0.00	

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	FC	Ch	Co	WS	Known	Pre.	Pot.	Total	Puncheon	Fishway	Gate	Weir	Inlet	Culverts	
Skamokawa Creek Slough (----)	X	X	X	X	0.04	0.00	2.34	2.39	0.00	0.00	2.34	0.00	0.00	0.00	
Alger Creek (0197)			X	X	4.12	1.98	0.00	6.11	0.00	0.00	0.00	0.00	0.00	0.00	*
Risk Creek (0201)			X		0.85	0.00	1.44	2.29	0.00	0.00	1.44	0.00	0.00	0.00	*
W Fork Skamokawa (0207)		X	X	X	3.89	0.00	0.00	3.89	0.00	0.00	0.00	0.00	0.00	0.00	
West Valley Creek (0209)			X	X	2.34	1.59	0.00	3.93	0.00	0.00	0.00	0.00	0.00	0.00	*
Cadman Creek (0210)			X	X	0.67	0.40	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00	*
Kelly Creek (0212)			X	X	0.00	0.21	0.94	1.15	0.00	0.00	0.00	0.00	0.00	0.94	*
Kelly Creek Trib (----)			X	X	0.00	0.00	0.35	0.35	0.00	0.00	0.00	0.00	0.00	0.35	*
Eggman Creek (0213)			X	X	0.87	0.32	0.38	1.57	0.00	0.00	0.00	0.00	0.00	0.38	
Wilson Creek (0215)	X	X	X	X	5.97	2.85	0.00	8.82	0.00	0.00	0.00	0.00	0.00	0.00	
Bell Canyon Creek (0216)		X	X	X	0.54	1.05	0.00	1.59	0.00	0.00	0.00	0.00	0.00	0.00	
Wilson Creek Trib. (0218)			X	X	0.00	1.43	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	
Falk Creek (0222)			X	X	4.08	1.19	0.00	5.27	0.00	0.00	0.00	0.00	0.00	0.00	*
Pollard Creek (0223)			X	X	0.80	1.17	0.00	1.97	0.00	0.00	0.00	0.00	0.00	0.00	*
Left Fork Skamokawa (0224)	X		X	X	0.65	2.50	0.00	3.15	0.00	0.00	0.00	0.00	0.00	0.00	
McDonald Creek (0228)	X		X	X	1.03	1.71	0.00	2.75	0.00	0.00	0.00	0.00	0.00	0.00	
McDonald Cr. Trib. (0229)			X	X	0.00	0.60	0.61	1.21	0.00	0.00	0.00	0.00	0.00	0.61	
Standard Creek (0231)	X		X	X	1.51	1.87	0.00	3.38	0.00	0.00	0.00	0.00	0.00	0.00	
<b>Elochoman River (0236)</b>	X	X	X	X	20.33	0.00	0.00	20.33	0.00	0.00	0.00	0.00	0.00	0.00	
Nelson Creek (0241)			X		0.00	1.60	1.59	3.20	0.00	0.00	0.00	0.00	0.00	1.59	*
Beaver Creek (0247)			X	X	0.10	0.00	2.58	2.68	0.00	0.00	0.00	2.58	0.00	0.00	*
Duck Creek (0251)			X	X	1.75	1.11	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	
Clear Creek (0253)				X	0.72	0.97	0.00	1.69	0.00	0.00	0.00	0.00	0.00	0.00	
Rock Creek (0255)			X	X	0.00	0.04	0.77	0.81	0.00	0.00	0.00	0.00	0.00	0.77	*
West Fork Elochoman (0259)			X	X	3.20	2.56	0.00	5.76	0.00	0.00	0.00	0.00	0.00	0.00	*

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	FC	Ch	Co	WS	Known	Pre.	Pot.	Total	Puncheon	Fishway	Gate	Weir	Inlet	Culverts	
Elochoman R. Trib. (0267)			X		0.39	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	
N. Fork Elochoman (0264)			X	X	2.24	0.00	0.00	2.24	0.00	0.00	0.00	0.00	0.00	0.00	
N.Fk. Eloch. Trib. (0265)			X	X	0.82	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.00	
E. Fork Elochoman (0266)			X	X	2.26	2.60	0.00	4.86	0.00	0.00	0.00	0.00	0.00	0.00	
Otter Creek (0268)			X	X	0.64	1.61	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.00	
Birnie Creek (0281)			X		0.00	0.00	1.42	1.42	0.00	0.00	1.42	0.00	0.00	0.00	*
<b>Mill/Abernathy/Germany Subbasin</b>															
Mill Creek (0284)	X	X	X	X	2.71	3.25	1.73	7.70	0.00	0.00	0.00	0.00	0.00	1.73	
South Fork Mill Creek (0285)			X	X	0.00	6.71	0.00	6.71	0.00	0.00	0.00	0.00	0.00	0.00	
Spruce Creek (0288)				X	0.00	2.77	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	
North Fork Mill Cr (0293)				X	0.00	2.28	0.00	2.28	0.00	0.00	0.00	0.00	0.00	0.00	
Abernathy Creek (0297)	X	X	X	X	9.76	0.00	0.00	9.76	0.00	0.00	0.00	0.00	0.00	0.00	
Cameron Creek (0298)		X	X	X	3.13	1.39	0.00	4.52	0.00	0.00	0.00	0.00	0.00	0.00	
Slide Creek (0302)				X	0.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	
Wiest Creek (0303)			X	X	2.19	1.70	0.00	3.89	0.00	0.00	0.00	0.00	0.00	0.00	
Erick Creek (0304)			X	X	0.68	0.83	0.89	2.41	0.00	0.00	0.00	0.00	0.00	0.89	
Midway Creek (0305)			X	X	0.00	0.20	0.70	0.90	0.00	0.00	0.00	0.00	0.00	0.70	
Abernathy Creek Trib. (0307)				X	3.28	0.00	0.00	3.28	0.00	0.00	0.00	0.00	0.00	0.00	
Ordway Creek (0309)			X	X	1.64	1.57	0.00	3.21	0.00	0.00	0.00	0.00	0.00	0.00	
Germany Creek (0313)	X	X	X	X	11.04	1.52	0.00	12.56	0.00	0.00	0.00	0.00	0.00	0.00	
Germany Creek Trib. A				X	0.00	0.99	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	
Germany Creek Trib. B				X	0.00	0.02	0.85	0.87	0.00	0.00	0.00	0.00	0.00	0.85	
Germany Creek Trib. C				X	0.00	0.02	1.41	1.43	0.00	0.00	0.00	0.00	0.00	1.41	
Germany Creek Trib. D				X	0.00	0.02	1.63	1.65	0.00	0.00	0.00	0.00	0.00	1.63	

**Table 18 WRIA 25 and Chinook River Fish Distribution and Barriers**

Stream	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)						
	FC	Ch	Co	WS	Known	Pre.	Pot.	Total	Puncheon	Fishway	Gate	Weir	Inlet	Culverts	
Germany Creek Trib. E				X	0.00	0.02	1.71	1.73	0.00	0.00	0.00	0.00	0.00	1.71	
Germany Creek Trib. F			X	X	0.00	0.78	0.18	0.96	0.00	0.00	0.00	0.00	0.00	0.18	
Germany Creek Trib. G				X	0.00	0.05	0.33	0.38	0.33	0.00	0.00	0.00	0.00	0.00	
Coal Creek (0340)	X	X	X	X	0.00	8.17	0.57	8.75	0.00	0.00	0.00	0.00	0.00	0.57	
Harmony (Mosquito) (0342)			X	X	0.00	0.95	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	
Stewart Creek (0344)				X	0.00	0.83	0.97	1.80	0.00	0.00	0.00	0.00	0.00	0.97	
Clark Creek (0370)			X	X	0.00	0.79	4.00	4.79	0.00	0.00	0.00	0.00	0.00	4.00	

Ch = Chum

FC = Fall Chinook

WS = Winter Steelhead

Co = Coho

Know. = Known Presence

Pre. = Presumed Presence

Pot. = Potential Presence

(1023) = Stream catalog number

*Winter Steelhead Distribution was used to denote miles of Known, Presumed, and Potential habitat except where coho salmon distribution was greater.*

\* = Coho distribution used

**Table 19:** Summary of WRIA 25 Fish Distribution and Barriers by Watershed

Watershed	Species Present				Miles of Use				Artificial, Physical Barriers (Miles Affected)					
	<i>FC</i>	<i>Ch</i>	<i>Co</i>	<i>WS</i>	<i>Known</i>	<i>Pre.</i>	<i>Pot.</i>	<i>Total</i>	<i>Puncheon</i>	<i>Fishway</i>	<i>Gate</i>	<i>Weir</i>	<i>Inlet</i>	<i>Culverts</i>
<b>Chinook</b>	X	X	X	X	15.07	0.15	0.33	15.55	0.00	0.00	0.00	0.00	0.33	0.00
<b>Grays</b>	X	X	X	X	55.35	39.98	3.92	99.26	0.00	1.01	1.74	0.00	0.00	1.17
<b>Skamokawa</b>	X	X	X	X	34.17	18.88	6.06	59.12	0.00	0.00	3.78	0.00	0.00	2.28
<b>Elochoman</b>	X	X	X	X	32.45	10.48	4.95	47.88	0.00	0.00	0.00	2.58	0.00	2.36
<b>Mill</b>	X	X	X	X	2.71	15.02	1.73	19.46	0.00	0.00	0.00	0.00	0.00	1.73
<b>Abernathy</b>	X	X	X	X	20.68	8.70	1.60	30.97	0.00	0.00	0.00	0.00	0.00	1.60
<b>Germany</b>	X	X	X	X	11.04	3.42	6.11	20.56	0.33	0.00	0.00	0.00	0.00	5.78
<b>Coal/Clark</b>	X	X	X	X	0.00	10.75	5.54	16.29	0.00	0.00	0.00	0.00	0.00	5.54
<b>WRIA 25 Totals</b>					<b>171.47</b>	<b>107.38</b>	<b>30.24</b>	<b>309.09</b>	<b>0.33</b>	<b>1.01</b>	<b>5.52</b>	<b>2.58</b>	<b>0.33</b>	<b>20.46</b>

## **Stock Descriptions**

### Spring Chinook (*Oncorhynchus tshawytscha*)

WDFW does not recognize spring chinook as a native stock within any WRIA 25 streams. Spring, summer, and “up-river bright” chinook have been released into the Grays-Elochoman basin (WRIA 25) in 1982, 1983, 1985, 1986 and 1987 (WDF et al. 1993).

### Fall Chinook (*Oncorhynchus tshawytscha*)

Fall chinook are native to the Chinook River in WRIA 24 and in the Grays and Elochoman Rivers in WRIA 25. It is unknown if they are native to Skamokawa Creek. Fall chinook are currently found in Mill, Abernathy, and Germany creeks. It is the opinion of WDFW that they were not found in these streams until the Abernathy Fish Technology Center began to produce fall chinook (WDF et al. 1993).

#### *Chinook River Fall Chinook*

Chinook River fall chinook are not recognized by WDFW as a separate stock and therefore stock status is largely unknown (WDF et al. 1993). Natural runs of chinook have been essentially extinct in the Chinook basin for almost a century. One of the earliest hatcheries in Washington State began on the Chinook River in 1895 and operated till 1935. Sea Resources Hatchery has been operating as a salmon hatchery on the lower Chinook River since 1967. Only one pair of fall chinook salmon was captured at the Sea Resources hatchery during its first year of operation as an educational institution in 1967. By 1996, 100 returning fall chinook were allowed upstream of the hatchery to spawn (Dewberry 1997).

#### *Grays River Fall Chinook*

Fall chinook are native to the Grays River. The natural spawners are now a mixed stock of composite production (Table 21). Stock mixing very likely began when hatchery supplementation was initiated in 1947 (WDF et al. 1993). The majority of spawning takes place in a 3.6-mile area from the covered bridge on the mainstem (RM 10.7) to the Grays River Salmon Hatchery on the West Fork Grays (RM 1.2). Spawning occurs from late September to mid-November (WDF et al. 1993).

In the early 1950s, there was an estimated escapement of 1,000 fall chinook to the Grays River (WDF 1951). Seining in 1979 captured few naturally-produced, fall chinook juveniles. This evidence suggests that few natural fall chinook juveniles were being produced (WDF et al. 1993).

Natural spawning escapements from 1967 to 1991 averaged 745 fish, with a low return of 147 in 1967 and a peak of 2,685 in 1978. Natural spawning escapements of 278 fish in

1990 and 200 fish in 1991 are below average, but are probably a result of natural fluctuations based on comparable, smaller, natural-spawning escapements for other lower Columbia River stocks. The magnitude of straying of lower-river hatchery fall chinook may also create fluctuations in this stock. The 1993 SASSI document considered this stock healthy, based on the escapement trends (see Table 20) (WDF et al. 1993).

#### *Skamokawa Creek Fall Chinook*

Fall chinook may not be native to Skamokawa Creek. The natural spawners are now a mixed stock of composite production (see Table 21) (WDF et al. 1993). This stock is widely mixed because of egg transfers between hatcheries and straying from a number of Oregon and Washington hatcheries (many coded-wire tags have been recovered). The majority of spawning takes place in a 4.5-mile area from Wilson Creek (RM 2.1) to Standard and McDonald creeks (RM 6.6). Spawning generally takes place during September (WDF et al. 1993).

SASSI (WDF et al. 1993) considered this stock healthy, based on the escapement trends (see Table 20). Natural spawning escapements from 1967 to 1991 averaged 2,038, with a low return of 184 in 1980 and a peak of 5,596 in 1985. Natural spawning escapements since 1986 are below average but are probably a result of natural fluctuations based on comparable, smaller, natural spawning escapements for other lower Columbia River stocks. The magnitude of straying lower Columbia River hatchery fall chinook may also create fluctuations in Skamokawa Creek fall chinook natural spawning escapements. Evidence suggests that few natural fall chinook juveniles are produced in Skamokawa Creek. McIsaac (1976) estimated the number of natural, juvenile fall chinook that migrated from Skamokawa Creek in 1976 was 6,109 fish from 5,446 natural spawners in 1975 (WDF et al. 1993).

#### *Elochoman Fall Chinook*

Fall chinook are native to the Elochoman River and are a mixed stock of composite production (see Table 21). The majority of spawning takes place in a 6.0-mile area from the Foster Risk Road Bridge (RM 2.1) to the Elochoman Salmon Hatchery. A substantial number of fall chinook also spawn downstream from the weir near RM 4.0 (WDF et al. 1993). WDF (1951) reported in the early 1950s that almost the entire escapement of fall chinook spawned in a 3.5-mile area from RM 3.0 to 6.5. Spawning generally takes place from late September to mid-November (WDF et al. 1993). In 1950, it was estimated that the Elochoman River spawning generally occurred between mid September and mid October, with the peak during late September (WDF 1951).

Coded-wire tagged fall chinook, including several stocks from Oregon, and tule stock, primarily from the Grays River, have been recovered from the Elochoman River. The overall result of straying fall chinook and egg transfers between hatcheries is the development of a widely-mixed stock (WDF et al. 1993). In addition, WDF (1951) reported in 1950 that 70,000 hatchery-reared fall chinook were released into streams in the Elochoman watershed and that this was the only recorded planting of salmon in the area till then. In 1950, the estimated annual escapement of fall chinook in the Elochoman

River was 2,000 fish, which spawned in the lower portions of the main river (WDF 1951).

SASSI (WDF et al. 1993) considered the Elochoman fall chinook stock healthy, based on the escapement trends (see Table 20). Natural spawning escapements from 1967 to 1991 averaged 680, with a low return of 64 in 1980 and a peak of 2,458 in 1987. Natural spawning escapements since 1989 are below average, but are probably a result of natural fluctuations based on comparable, smaller, natural spawning escapements for other lower Columbia River stocks.

#### *Mill Creek Fall Chinook*

Fall chinook may not be native to Mill Creek. The natural spawners are a mixed stock of composite production (see Table 21). The majority of spawning occurs along approximately 2 miles, starting at the mouth of the Mill Creek. Spawning occurs from September to October (WDF et al. 1993).

Straying, hatchery, coded-wire-tagged fish from a number of Oregon and Washington hatcheries, including nearby Abernathy Creek, have been recovered from Mill Creek, resulting in a widely-mixed stock. This stock is considered to be healthy, based on the escapement trends (see Table 20). Natural spawning escapements from 1984 to 1991 averaged 566, with a low return of 2 in 1985 and a peak of 1,867 in 1987. Mill Creek natural spawning escapements since 1990 are below average, but are probably a result of natural fluctuations based on comparable, smaller, natural spawning escapements for other lower Columbia River stocks. The magnitude of straying by lower-river hatchery fall chinook may also create severe fluctuations in the Mill Creek stock (WDF et al. 1993).

#### *Abernathy Creek Fall Chinook*

Fall chinook may not be native to Abernathy Creek. In 1951, WDF did not recognize a natural fall chinook run. The natural spawners are now a mixed stock of composite production (see Table 21). The majority of spawning takes place in a 3-mile area, from the mouth to the Abernathy Creek National Fish Hatchery. Spawning occurs from late September to mid-November (WDF et al. 1993).

The first fall chinook plantings began in 1950 (WDF 1951). In addition, straying hatchery fish tagged with a coded-wire from a number of Oregon and Washington hatcheries have been recovered from Abernathy Creek. Tule stock from lower river hatcheries (primarily Abernathy, Grays River, and Elochoman) have been recovered from Abernathy Creek. These strays and numerous egg transfers have resulted in a widely mixed stock. SASSI considered the Abernathy fall chinook stock healthy, based on the escapement trends (see Table 20) (WDF et al. 1993).

Natural spawning escapements from 1981 to 1991 averaged 1,616, with a low return of 316 in 1990 and a peak of 3,917 in 1987. Abernathy Creek natural spawning escapements between 1988 and 1990 were below average, but are probably a result of

natural fluctuations based on comparable, smaller, natural spawning escapements for other lower Columbia River stocks. The magnitude of straying, lower-river hatchery fall chinook may also create severe fluctuations in the Abernathy Creek stock.

#### *Germany Creek Fall Chinook*

Fall chinook may not be native to Germany Creek. The natural spawners are a mixed stock of composite production (see Table 21). The majority of spawning takes place from the mouth to RM 3.5, and occurs during September (WDF et al. 1993).

Straying hatchery fish tagged with a coded-wire from a number of Oregon and Washington hatcheries (including Abernathy National Fish Hatchery) have been recovered from Germany Creek. These strays and numerous egg transfers have resulted in a widely-mixed stock. SASSI (WDF et al. 1993) considered Germany Creek fall chinook stock healthy based on the escapement trends (see Table 20). Natural spawning escapements from 1982 to 1991 averaged 364, with a low return of 57 in 1986 and a peak of 1,234 in 1988. Germany Creek natural spawning escapements since 1990 were below average, but are probably a result of natural fluctuations based on comparable, smaller, natural spawning escapements for other lower Columbia River stocks. The magnitude of straying by lower-river hatchery fall chinook may also create severe fluctuations in the Germany Creek stock.

**Table 20 - WRIA 25 Fall Chinook SASSI Stock Status**

Stock	Screening Criteria	1992 SASSI Stock Status	Status (ESA Listing)
Grays River	Escapement Trend	Healthy	Federal – “Endangered”
Skamokawa Creek	Escapement Trend	Healthy	Federal – “Endangered”
Elochoman River	Escapement Trend	Healthy	Federal – “Endangered”
Mill Creek	Escapement Trend	Healthy	Federal – “Endangered”
Abernathy Creek	Escapement Trend	Healthy	Federal – “Endangered”
Germany Creek	Escapement Trend	Healthy	Federal – “Endangered”

Adapted from WDF et al. 1993.

**Table 21 - WRIA 25 Fall Chinook Stocks**

Stock	Stock Origin	Production Type
Grays River	Mixed	Composite
Skamokawa Creek	Mixed	Composite
Elochoman River	Mixed	Composite
Mill Creek	Mixed	Composite
Abernathy Creek	Mixed	Composite
Germany Creek	Mixed	Composite

Adapted from WDF et al. 1993.

### Chum Salmon (*Oncorhynchus keta*)

Once widespread in the lower Columbia River, native chum salmon production today is concentrated in the Grays River system and near Bonneville Dam in Hardy and Hamilton creeks. Many lower Columbia tributaries once produced chum (WDF et al. 1993). An evaluation is underway to determine the genetics of these stocks. Some non-native chum introductions have been attempted, with apparently no success. They are now federally listed as a threatened species in WRIA 24 and 25.

#### *Chinook River Chum*

Chinook River chum are not recognized as a separate stock by WDFW. Natural runs of chum have been essentially extinct in the Chinook basin for almost a century (Dewberry, 1997). WDFW (1951) estimated that the chum escapement to the Chinook and Deep Rivers, and Crooked and Jim Crow Creeks were at least 1,200 fish. Chum salmon are one of the major stocks managed at Sea Resources Hatchery (Dewberry 1997). Until recently, the Sea Resources Hatchery raised chum using Bear River (Willapa Bay) stock. Plans call for replacing this non-native stock with local stocks from the nearby Grays River (Keller 1999). The Sea Resources Hatchery returns in 1997 and 1998 were 11 and 17, respectively (Keller 1999).

#### *Deep River, Crooked Creek, Jim Crow Creek, and Alger Creek Chum*

It was estimated that the chum escapement to the Chinook and Deep rivers and Crooked and Jim Crow creeks were at least 1,200 fish (WDF 1951). WDF (1973) reported chum presence in South Fork Crooked Creek and Alger Creek.

#### *Grays River Fall Chum*

Chum are believed to enter the river in October and November and reach their spawning peak in early November. Chum spawn in the mainstem Grays from the covered bridge to approximately 0.5 mile upstream of the West Fork confluence (approximately 4 miles). Tributary spawning occurs in the West Fork (RM 13.0), Crazy Johnson Creek (RM 13.3), and Gorley Creek (RM 12) during November and December (WDF et al. 1993). They are also reported to spawn in Fossil Creek (RM 12.4), and Hull Creek (RM 8.2) (Ames and Bergh 1971). In the 1970s, chum spawning index areas existed in Sweigiler Creek (RM 4.1 of the West Fork Grays) and in the South Fork Grays River (RM 17.7) (Jim Fisher and Associates 1999). Wahkiakum Conservation District reports chum spawning in Klints Creek (RM 11.9). In 1973, WDF reported chum presence in Seal Creek (RM 0.15 on Seal Slough) and Malone Creek (RM 2.1), but does not state whether they were spawning in these creeks (Smith et al 1954).

Grays River chum production has drastically declined from former abundance levels. Several attempts have been made to augment natural chum production with releases from the Grays River Hatchery. Releases from 1982 to 1991 have included juveniles resulting from small numbers of adults trapped at Grays hatchery and fish of Hood Canal and Japanese origin. Hatchery releases have failed to produce significant adult returns (WDF et al. 1993). Impacts from hatchery operations on chum populations have not been

determined. It is possible that predation of chum juveniles by hatchery smolts is occurring in the Grays River system (WDF et al. 1993).

During the first stream survey of the Grays River on November 11, 1936, the survey crew counted 1,388 chum in the first 3.2 miles of the West Fork Grays River (Bryant 1949). In 1951, WDF estimated annual chum escapement in the lower mainstem Grays River at 7,500 fish (WDF 1951). In 1954, WDF estimated the average chum escapement at 2,000 fish in the mainstem Grays River, 200 to 500 in Hull Creek, 20 in Falls Creek (tributary to Hull Creek)(Smith et al. 1954).

Currently, Grays River chum are considered to be depressed. Average multi-year, fish-per-mile values from 1944 to 1991 were calculated. These data show a sharp decline in spawning escapement beginning in about 1960. Average fish-per-mile values ranged from 78 to 693 fish, with the low of 9 in 1981 and a high of 269 in 1988 (WDF et al. 1993).

In 1996, it was estimated that total chum returns to the Columbia River were 3,330 fish. An estimated 2,588 chum returned to the Grays River system, with 1,302 in the mainstem Grays, 408 in the West Fork Grays, 463 in Crazy Johnson Creek, and 414 in both the new and old channel of Gorley Creek. Of the chum returning to the Grays River system in 1996, it is estimated that 50 percent spawned in the tributaries. Seining in the spring of 1997 showed there was good survival of juveniles in Gorley Creek (Keller 1997).

In 1996, a pilot project was conducted to help protect chum. Adults were spawned and eggs were held at the Grays River Hatchery. A total of 7,075 smolts were released in April 1997 into the West Fork Grays (Keller 1999).

In 1998, it was estimated that total chum returns to the Columbia River were 1,864 fish. An estimated 943 chum returned to the Grays River system. Of the chum returning to the Grays River system in 1998, it is estimated that 84 percent spawned in the tributaries (Keller 1999).

#### *Skamokawa Creek Chum*

Skamokawa Creek chum are not recognized as a separate stock by WDFW. WDF (1951) estimated that 3,000 chum spawned each year in Skamokawa Creek. The spawning area was described as the first three to four miles above the tidal influence. In 1973, WDF reported chum presence in the West Fork Skamokawa (RM 1.1), Wilson Creek (RM 2.1), Falk Creek (RM 2.15), Pollard Creek (RM 0.25 of Falk Creek), and the Left Fork Skamokawa Creek (RM 4.9).

#### *Elochoman River Chum*

Elochoman River chum are not recognized as a separate stock by WDFW. WDF 1973 described the spawning area as the first two to three miles above the tidal influence. WDF also reported that chum enter Beaver Creek (WDF 1973). In their 1951 report, WDF estimated annual chum escapement to the Elochoman River at 1,000 fish. In 1954,

WDF estimated the average chum escapement in the Elochoman River at 500 fish (Smith et al. 1954). In 1973, WDF reported that 364,000 chum were planted in the Elochoman in 1966 and 43,350 were planted in 1969 (WDF 1973).

#### *Mill/Abernathy/Germany/Coal Creek Chum*

Chum from the Abernathy/Mill/Germany area are not recognized as a separate stock by WDFW. WDF (1951) reports that peak spawning time was in early November. Spawning took place on the first available gravel, usually in the first two to three miles (WDF 1951). In 1951, WDF estimated that 2,700 chum spawn each year in this area, and were generally distributed in the following manner: 1,000 in Mill Creek, 300 in Abernathy Creek, 1,000 in Germany Creek, and 400 in Coal Creek. In 1954, WDF estimated the average chum escapement in Mill Creek to be 100 fish, with 200 to 300 in Abernathy Creek, and 200 to 300 in Germany Creek (Smith et al. 1954). Chum are also reported to be in Harmony (Mosquito) Creek, (Coal Creek tributary) and in Cameron and Slide Creek (Abernathy tributaries) (WDF 1973).

#### Coho Salmon (*Oncorhynchus kisutch*)

Native coho had a widespread distribution in WRIA 25 and the lower Columbia tributaries of WRIA 24. Natural coho production is considered to be depressed in all areas. Lower Columbia River coho are an ESA candidate species. Due to past hatchery practices, all stocks are mixed and of composite production (WDF et al. 1993). Hatchery practices have stratified coho production into two groups, “early” and “late coho, to meet harvest management requirements. The early group generally spawns from October to early November, and the late group spawns from late November to December. Most Columbia River basins probably still support both early and late coho; however, the dominant group in a particular basin probably follows the dominantly timed group which is cultured in a nearby hatchery (WDF et al. 1993).

#### *Chinook River Deep River, Crooked Creek, Jim Crow Creek, and Alger Creek Coho*

Chinook River coho are not recognized by WDFW as a separate stock (WDF et al. 1993). WDFW (1951) estimated the total escapement to the Chinook and Deep Rivers and in Crooked and Jim Crow Creeks to be at least 600 fish. Coho fry, of an unknown source, were planted in the Chinook River in 1968 (WDF 1973). They have been observed spawning in the mainstem Chinook River above the Sea Resources Hatchery to a short distance above the major forks (Dewberry 1997).

WDF (1951) reported the estimated total escapement to the Chinook and Deep Rivers and in Crooked and Jim Crow Creeks to be at least 600 fish. None of the streams has a distinctive coho stock recognized by SASSI.

#### *Grays River Coho*

Coho salmon are native to the Grays River. The natural spawners are a mixed stock of composite production (see Table 23). Coho generally enter the Grays River from early September to mid-February, and spawning occurs mid-October to mid-February. The

dominant spawning of natural production is probably later than fish of hatchery production. Hatchery fish are generally “early” coho and spawn in October and November (WDF et al. 1993). In the early 1950s, WDF reported that coho spawned from late October until well into March, if river conditions remain favorable (WDF 1951).

Stock mixing very likely began when hatchery supplementation began, at least as early as 1965. This stock is considered to be depressed, based on chronically low production (see Table 22). Coho are thought to spawn in all available tributaries, though natural spawning escapements were not available in the SASSI report (WDF et al. 1993). WDF (1951) reported the estimated escapement in the Grays River of at least 2,500 fish.

U.S. Fish and Wildlife Service surveys in 1936 and 1937 indicated coho were present in all accessible tributaries of the Grays River, but no population estimates were made (Bryant 1949). In 1951, Washington Department of Fisheries estimated a coho escapement of at least 2,500 fish (WDF 1951).

SASSI (WDF et al. 1993) states that the hatchery built on the West Fork Grays River in 1960, and subsequent harvest management for hatchery productivity in the region has been a significant factor affecting natural production. A number of tributaries of the Grays River have good coho production potential. Among these are Hull, Fossil, and Mitchell creeks, and the West, East, North, and South Forks of the Grays River (WDF 1973).

#### *Skamokawa Creek Coho*

Coho salmon are native to Skamokawa Creek (WDF 1951). Natural spawners in Skamokawa Creek are now a mixed stock of composite production (see Table 23). Natural spawning in the Skamokawa Creek watershed occurs in the mainstem, Wilson Creek, Left Fork Skamokawa, Quartz Creek, Standard Creek, and McDonald Creek (WDF et al. 1993). Coho are thought to spawn in all available tributaries in this area (WDF et al. 1993). They spawn from late November until well into March if water conditions are favorable (WDF 1951).

WDF (1951) reported an annual escapement of 2,000 coho to this watershed. SASSI (WDF et al. 1993) considered Skamokawa Creek coho depressed based on chronically low production (see Table 22). Spawning escapements were not available in the SASSI report.

#### *Elochoman River Coho*

Coho are native to the Elochoman River. Coho river entry in the Elochoman River occurs from early September to February, and spawning occurs in most available tributaries from mid-October to March. Natural spawning is presumed (through unpublished information) to be quite low, and subsequent production is below stream potential (WDF et al. 1993). Coho spawn in the mainstem and in the West and East Forks of the Elochoman, as well as in Beaver, Duck, and Otter Creeks, from late November until well into March if water conditions are favorable (WDF 1951).

The natural spawners are a mixed stock of composite production (see Table 23). Stock mixing very likely began when hatchery supplementation began, at least as early as 1965. This stock was considered depressed, based on chronically low production (see Table 22). Natural spawning escapements are not known because no directed surveys are done on the Elochoman coho (WDF et al. 1993).

U.S. Fish and Wildlife Service surveys in 1936 and 1937 indicated coho were present in all accessible tributaries of the Elochoman River, but no population estimates were made. Portions of the watershed at this time were experiencing splash damming and logging through the streams, which probably had adversely affected fish production (WDF et al. 1993).

SASSI (WDF et al. 1993) states that the hatchery was built on the Elochoman River at RM 7.0 in 1953, and subsequent harvest management for hatchery productivity in the region has been a significant factor affecting natural production. A number of Elochoman River tributaries have good coho production potential. Among these are Duck, Beaver, and Clear creeks, and the West, East, and North Forks (WDF et al. 1993).

WDF (1951) reported an annual escapement of 2,500 coho to this watershed. Current escapement estimates were not included in the SASSI report (WDF et al. 1993).

#### *Mill Creek Coho*

Natural spawners in Mill Creek are a mixed stock of composite production (see Table 23). This stock is considered depressed, based on chronically low production (see Table 22). Coho are thought to spawn in all available tributaries, although natural spawning escapements were not listed in the SASSI report (WDF et al. 1993).

In 1951, WDF estimated annual returns of 300 coho to Mill Creek and reported that they spawned up to RM 1.25 where a 7-foot falls was only passable with extreme difficulty at high flows. In 1950, this obstruction was blasted to create a more suitable passage, and it added 7 to 8 miles of spawning and rearing grounds for coho.

#### *Abernathy Creek Coho*

Natural spawners in Abernathy Creek are a mixed stock of composite production (see Table 23). This stock is considered to be depressed, based on chronically low production (see Table 22) (WDF et al. 1993).

In 1950, coho releases began in Abernathy Creek (WDF 1951). In 1951, WDF estimated annual returns of 100 coho to Abernathy Creek and reported that they spawn in the limited area below the 10-foot falls located at RM 3.5, and that a small number spawn in Cameron Creek.

### *Germany Creek Coho*

Natural spawners in Germany Creek are a mixed stock of composite production (see Table 23). This stock is considered to be depressed, based on chronically low production (see Table 22). Natural spawning is presumed (through unpublished information) to be quite low and subsequent juvenile production minor (WDF et al. 1993).

In 1950, coho releases began in Abernathy Creek (WDF 1951). In 1951, WDF estimated annual returns of 200 coho to Germany Creek and reported that they spawn in almost the entire drainage. In 1954, WDF estimated annual returns of 300 to 500 coho (Smith et al. 1954).

### *Coal Creek Coho*

Coal Creek coho are not recognized by WDFW as a separate stock (WDF et al. 1993). In 1951, WDF estimated annual returns of 200 coho to Coal Creek and reported that they spawn in the lower 3.2 miles. An impassable, double falls with a lower drop of 12 feet and an upper drop of 6 feet impede migration. The location of this falls was not given.

**Table 22 - WRIA 25 Coho SASSI Stock Status**

<b>Stock</b>	<b>Screening Criteria</b>	<b>1992 SASSI Stock Status</b>	<b>Status (ESA Listing)</b>
Grays River	Chronically-Low Production	Depressed	Candidate Species
Skamokawa Creek	Chronically-Low Production	Depressed	Candidate Species
Elochoman River	Chronically-Low Production	Depressed	Candidate Species
Mill Creek	Chronically-Low Production	Depressed	Candidate Species
Abernathy Creek	Chronically-Low Production	Depressed	Candidate Species
Germany Creek	Chronically-Low Production	Depressed	Candidate Species

Adapted from WDF et al. 1993.

**Table 23 - WRIA 25 Coho Stocks**

<b>Stock</b>	<b>Stock Origin</b>	<b>Production Type</b>
Grays River	Mixed	Composite
Skamokawa Creek	Mixed	Composite
Elochoman River	Mixed	Composite
Mill Creek	Mixed	Composite
Abernathy Creek	Mixed	Composite
Germany Creek	Mixed	Composite

Adapted from WDF et al. 1993.

### Winter Steelhead (*Oncorhynchus mykiss*)

There is little or no information available to indicate that WRIA 25 winter steelhead stocks are genetically distinct from one another. The stocks are treated separately by WDFW due to geographical isolation of spawning populations (WDF et al. 1993).

#### *Chinook River Winter Steelhead*

Chinook River winter steelhead are not recognized as a separate stock by WDFW. Sea Resources reports that steelhead are found throughout the basin in “average abundance” (Dewberry 1997).

#### *Grays River Winter Steelhead*

Winter steelhead are native to the Grays River. The natural spawners are considered to be a native stock of wild production (see Table 25). Winter steelhead river entry in the Grays River occurs from early December to April, and spawning occurs from early March to late May or early June, primarily in the middle and upper basin (WDF et al. 1993).

Hatchery winter steelhead of mixed stocks have been planted in the Grays River since 1957. SASSI (WDF et al. 1993) states that there is little contribution to the wild population by hatchery fish spawning in the wild. Subsequent reports (Draft LCSCI: State of Washington 1998) show that in the index areas, 14 percent of the total number of spawners were hatchery fish.

This stock is considered to be depressed, based on chronically low production. The escapement goal for the Grays River is 1,486 fish. Escapements have averaged 56 percent (831 fish) of the escapement goal from 1991 to 1996 (see Table 25) (Draft LCSCI: State of Washington 1998).

#### *Skamokawa Creek Winter Steelhead*

Winter steelhead are native to Skamokawa Creek. The natural spawners are considered to be a native stock of wild production (see Table 24). Winter steelhead river entry in Skamokawa Creek occurs from early December to April, and spawning occurs from early March to late May or early June (WDF et al. 1993).

Mixed stocks of hatchery winter steelhead have been planted in Skamokawa Creek since 1966. SASSI (WDF et al. 1993) states that there is little contribution to the wild population by hatchery fish spawning in the wild. Subsequent reports (Draft LCSCI: State of Washington 1998) show that in the index areas, 29 percent of the total number of spawners were hatchery fish (see Table 25).

This stock is considered to be depressed, based on chronically low production. The escapement goal for Skamokawa Creek is 227 fish. Escapements have averaged 95

percent (216 fish) of the escapement goal from 1991 to 1996 (see Table 25) (Draft LCSCI: State of Washington 1998).

#### *Elochoman River Winter Steelhead*

Winter steelhead are native to the Elochoman River. The natural spawners are considered to be a native stock of wild production (see Table 24). Winter steelhead river entry in the Elochoman River occurs from December to April, and spawning occurs from early March to late May or early June (WDF et al. 1993).

Mixed stocks of hatchery winter steelhead have been planted in the Elochoman River since 1955. SASSI (WDF et al. 1993) states that there is little contribution to the wild population by hatchery fish spawning in the wild. Subsequent reports (Draft LCSCI: State of Washington 1998) show that in the index areas, 29 percent of the total number of spawners were hatchery fish (see Table 25).

This stock is considered to be depressed, based on chronically low production. The escapement goal for the Elochoman River is 626 fish. Escapements have averaged 38 percent (237 fish) of the escapement goal from 1991 to 1996 (see Table 25) (Draft LCSCI: State of Washington 1998).

#### *Mill Creek Winter Steelhead*

Winter steelhead are native to Mill Creek. The natural spawners are considered to be a native stock of wild production (see SCI: State of Washington 1998).

Table 24). Winter steelhead river entry in Mill Creek occurs from December to April, and spawning occurs from early March to late May or early June (WDF et al. 1993).

Stocks from other hatcheries have rarely been planted in Mill Creek (WDF et al. 1993). The percentage of the total number of natural spawners that are hatchery fish is unavailable (Draft LCSCI: State of Washington 1998).

This stock is assumed to be depressed, based on chronically low production in nearby Abernathy Creek. Escapement goals have not been determined and there are no estimates of returning fish to Mill Creek (see Table 25) (WDF et al. 1993).

#### *Abernathy Creek Winter Steelhead*

Winter steelhead are native to Abernathy Creek. The natural spawners are considered to be a native stock of wild production (see Table 24). Winter steelhead river entry in the Abernathy Creek occurs from December to April, and spawning occurs from early March to late May or early June (WDF et al. 1993).

Hatchery winter steelhead of mixed stocks have been planted in the Abernathy Creek since 1955. SASSI (WDF et al. 1993) states that there is little contribution to the wild

population by hatchery fish spawning in the wild. Subsequent reports (Draft LCSCI: State of Washington 1998) show that in the index areas, 17 percent of the total number of spawners were hatchery fish (see Table 25).

This stock is considered to be depressed, based on chronically low production. The escapement goal for Abernathy Creek is 306 fish. Escapements have averaged 38 percent (141 fish) of the escapement goal from 1991 to 1996 (see Table 25) (Draft LCSCI: State of Washington 1998).

#### *Germany Creek Winter Steelhead*

Winter steelhead are native to Germany Creek. The natural spawners are considered to be a native stock of wild production (see Table 24). Winter steelhead river entry in the Germany Creek occurs from December to April, and spawning occurs from early March to late May or early June (WDF et al. 1993).

Hatchery winter steelhead of mixed stocks have been planted in the Germany Creek since 1955. SASSI (WDF et al. 1993) states that there is little contribution to the wild population by hatchery fish spawning in the wild. Subsequent reports (Draft LCSCI: State of Washington 1998) show that in the index areas, 23 percent of the total number of spawners were hatchery fish (see Table 25).

This stock is assumed to be depressed, based on chronically low production. The escapement goal for Germany Creek is 202 fish. Escapements have averaged 60 percent (122 fish) of the escapement goal from 1991 to 1996 (see Table 25) (Draft LCSCI: State of Washington 1998).

**Table 24: WRIA 25 Winter Steelhead Stock Status**

Stock	Screening Criteria	1992 SASSI Stock Status	1997 LCSCI Stock Status	Status (ESA Listing)
Grays River	Chronically Low	Depressed	Depressed	Not Federally Listed
Skamokawa Creek	---	Unknown	Depressed	Not Federally Listed
Elochoman River	Chronically Low	Depressed	Depressed	Not Federally Listed
Mill Creek	Chronically Low	Unknown	Unknown	Not Federally Listed
Abernathy Creek	Chronically Low	Depressed	Depressed	Not Federally Listed
Germany Creek	Chronically Low	Depressed	Depressed	Not Federally Listed

Adapted from WDF and WDW 1993; Lower Columbia Steelhead Conservation Initiative 1998.

**Table 25: WRIA 25 Winter Steelhead Escapement Estimates**

Stock	Wild Steelhead Escapement Goal	Average Wild Steelhead Escapement (1991-1996)	Average % of Wild Escapement Goals	Average % of Hatchery Spawners (1991-1996) <sup>1</sup>
Grays River	1,486	831	56 %	14 %
Skamokawa Creek	227	216	95 %	11 %
Elochoman River	626	237	38 %	29 %
Mill Creek	---	---	---	~ 0 %
Abernathy Creek	306	141	46 %	17 %
Germany Creek	202	122	60 %	23 %

<sup>1</sup> = Indicates index count, not total.

Adapted from Lower Columbia Steelhead Conservation Initiative, 1998.

### Sea-Run Cutthroat Trout (*Oncorhynchus clarki clarki*)

#### *Chinook River Coastal Cutthroat*

Chinook River cutthroat are not recognized as a separate stock by WDFW. Sea Resources reports that cutthroat are found throughout the basin and that fishing pressure on the mainstem may partially explain the low numbers (Dewberry 1997).

#### *Grays River Coastal Cutthroat*

Grays River coastal cutthroat are classified as a distinct stock complex, based on the geographic distribution of the spawning grounds. Anadromous, resident, and fluvial life-history forms distribute themselves throughout the watershed. The anadromous form has access to most of the watershed, with the exception of upper tributary reaches, where a combination of steep gradient and high flow can limit passage. The resident forms have been observed throughout the system (Blakley et al. 2000).

Data on Grays River coastal cutthroat are limited, and escapement numbers of wild fish are not available. WDFW believes that the run timing is similar to the Elochoman River stock, which enter the river from late July through mid April, with peak entry in the fall. Spawning in the Elochoman takes place from January through April. Fluvial and resident spawning times have not been documented, but are believed to be the same as for the anadromous forms (Blakley et al. 2000).

The genetic relationship of the Grays stock complex to other stock complexes is unknown. No genetic sampling and analysis have been done (Blakley et al. 2000).

Grays coastal cutthroat trout are native and are sustained by wild production. There is no record of hatchery cutthroat releases into the Grays River. The Grays River Hatchery was constructed in the late 1950s and has raised coho, fall chinook, and chum. Beaver Creek hatchery steelhead smolts (about 28,000) are released annually into the Grays River. Ecological impacts to coastal cutthroat from hatchery salmon and steelhead releases is unknown (Blakley et al. 2000).

The status of Grays River stock is depressed, based on a long-term decline in the Columbia River recreational catch estimates from RM 0 to RM 38 in 1972 to 1995. No distinctions among the life-history forms have been made, but numbers probably represent mainly anadromous and fluvial fish. Because the catch survey targeted salmon and steelhead, changes in cutthroat angling effort cannot be quantified. Columbia River catch data indicates a decline in cutthroat abundance over time (Blakley et al. 2000).

#### *Elochoman/Skamokawa Coastal Cutthroat*

Elochoman/Skamokawa coastal cutthroat have been identified as a distinct stock complex, based on the geographic proximity, small size, similar drainage characteristics, and the limited data available. The Elochoman/Skamokawa complex is represented by genetic samples from the Beaver Creek Hatchery (Elochoman watershed). Analysis showed that it was not significantly different from the Cowlitz stock complex; however, it was found to be genetically different from collections from the Kalama and Lewis Rivers (Blakley et al. 2000).

Anadromous, resident, and fluvial life-history forms distribute themselves throughout the watersheds. The anadromous form has access to most of the Elochoman watershed, with the exception of Beaver Creek where a WDFW weir blocks fish passage to maintain water quality for the hatchery; Duck Creek where a falls blocks entry; and upper tributary reaches, where a combination of steep gradient and high flow can limit passage. The resident forms have been observed throughout the system (Blakley et al. 2000).

The Elochoman Salmon Hatchery and Beaver Creek Hatchery were constructed in the late 1950s. The Elochoman hatchery raised coho, fall chinook, and chum. The Beaver Creek Hatchery raised winter steelhead and sea-run cutthroat trout and was closed in 1999 due to budget constraints. From 1989 to 1993, an average of 34,620 anadromous coastal cutthroat smolts were released into the Elochoman River each year from the Beaver Creek Hatchery. No hatchery cutthroat smolts were released into Skamokawa Creek. Ecological impacts to coastal cutthroat from hatchery salmon and steelhead releases is unknown (Blakley et al. 2000).

Entry of sea-run cutthroat into the Beaver Creek Hatchery is from August through March (Lucas 1980). Peak trapping for wild, anadromous cutthroat usually occurs from October through January, depending on river conditions. Spawning can occur from late December through early June (Lavier 1959); however, in most years, spawning occurs from January through April (WDFW, unpublished data). The anadromous spawn timing was determined from fish returning to the Beaver Creek Hatchery during years of initial anadromous-cutthroat, brood-stock collection. Artificial selection from early spawning time now has hatchery cutthroat spawning from December to February (Byrne 1995). Fluvial and resident spawning times have not been documented, but are believed to be the same as for the wild, anadromous forms (Blakley et al. 2000).

Elochoman/Skamokawa coastal cutthroat trout are considered to be native and are sustained by wild production (see Table 26). The status of Elochoman/Skamokawa stock

is depressed, based on chronically-low counts at the Elochoman and Beaver Creek hatcheries, and a long-term decline in the Columbia River cutthroat catch from RM 0 to RM 48 (see Table 27). Wild, anadromous escapement measured at the Elochoman River Hatchery has ranged between 10 and 20 sea-run cutthroat annually since 1992 (Dick Aksamit, WDFW, personal communications as cited in Blakely et al. 2000). The majority of these are unmarked fish. The trap is operated from September through December to capture coho salmon, and the efficiency of this trap for cutthroat trout is unknown. Trap counts of unmarked adult (wild) anadromous cutthroat from the upper and lower traps at Beaver Creek Hatchery are available from 1958 to 1995. The data are complete, but were not collected to assess stock status reports and their usefulness in this regard is unknown (Blakley et al. 2000).

Before anadromous hatchery cutthroat were introduced, 108 and 75 native cutthroat were captured in 1958-59 and 1959-60, respectively, in Beaver Creek. Unmarked returns from 1965 to 1970 averaged over 1,000 adults. It is likely that some of these fish were unmarked hatchery fish, offspring of hatchery fish spawning in the wild, and offspring of wild fish. By 1971, the numbers of unmarked fish were reduced to 43, and by 1980, the return was only 12 fish. After disease outbreaks at the hatchery in the early 1980s, adult cutthroat were not passed above the Beaver Creek traps in order to maintain water quality at the hatchery. By 1990, all smolts released were adipose-fin clipped, and since that time, the annual number of unmarked fish returning to the trap has been no more than five fish, with an average of three. Total returns to the hatchery and smolt-to-adult survival for hatchery smolts have both been low in recent years (Blakley et al. 2000).

There are no population-size data for resident cutthroat, so status of this life-history form cannot be assessed. Due to similarities to other salmonids regarding habitat and harvest, it is assumed that the resident cutthroat stock is also depressed (Blakley et al. 2000).

#### *Abernathy Creek/Germany Creek/Mill Creek/Coal Creek Coastal Cutthroat*

Abernathy Creek/Germany Creek/Mill Creek/Coal Creek coastal cutthroat have been identified as a distinct stock complex, based on the geographic distribution of the spawning grounds. Because of the proximity of the streams, their similar sizes and drainage characteristics, and limited biological information, cutthroat in these creeks have been combined into one stock. As more biological and genetic data become available, cutthroat in these creeks may be classified as separated stocks or stock complexes (Blakley et al. 2000).

Anadromous, resident, and fluvial life-history forms distribute themselves throughout these watersheds. The anadromous form has access to most of the watersheds, with the exception of upper tributary reaches, where a combination of steep gradient and high flow can limit passage, and the areas above the falls on Slide and Cameron creeks which are tributaries to Abernathy Creek. The resident cutthroat forms have been observed throughout the system (Blakley et al. 2000).

The Abernathy Fish Technology Center operated by the US Fish and Wildlife Service (USFWS) includes a hatchery on Abernathy Creek, which raises fall chinook. The hatchery began operations in 1960. The cutthroat program consisted of releasing cutthroat into Abernathy, Germany, and Mill creeks twice each year. The first release of smolts in April was intended to increase the numbers of anadromous fish. The second release was from the same group of fish, which were held, then released in late May. These fish had lost their smolt appearance and were intended to provide catchable fish for the opening day of fishing in late May (Lucas, 1980). In the early 1980s, the cutthroat program focus switched to the anadromous form, and the late-May releases were discontinued. From 1989 to 1993, an average of 5,700, 5,620, and 5,600 anadromous coastal cutthroat smolts were released annually into Mill, Abernathy, and Germany Creeks, respectively, from the Beaver Creek Hatchery on the Elochoman River. More recent hatchery releases were much smaller, with 2,000 smolts going only to Abernathy Creek. Interactions between hatchery and wild cutthroat remain a concern (Blakley et al. 2000).

Entry of sea-run cutthroat into the Abernathy, Germany, and Mill creeks is assumed to be similar to that of Elochoman fish, which enter the river from late July through mid April, with peak entry in the fall. Spawning occurs from January through April. Fluvial and resident spawning times have not been documented but are believed to be the same as for the wild, anadromous forms (Blakley et al. 2000).

Abernathy Creek/Germany Creek/Mill Creek coastal cutthroat trout are native and are sustained by wild production (see Table 26). The status of this stock is depressed, based on chronically-low counts at the Abernathy fish trap and a long-term decline in the Columbia River cutthroat catch from RM 48 to RM 56 (see Table 27). There are no population-size data for resident cutthroat, so status of this life-history form cannot be assessed. Due to similarities to other salmonids regarding habitat and harvest, it is assumed that the resident cutthroat stock is also depressed (Blakley et al. 2000).

**Table 26: WRIA 25 Sea-Run Cutthroat Stock Status**

Stock	Screening Criteria	2000 SaSSI Stock Status	Status (ESA Listing)
Grays River	Long-Term Negative Trend	Depressed	Federally proposed for listing
Elochoman/Skamokawa	Chronically Low, Long-Term Negative Trend	Depressed	Federally proposed for listing
Mill/Abernathy/Germany Creek	Long-Term Negative Trend	Depressed	Federally proposed for listing

Adapted from Blakley et al. 2000.

**Table 27: WRIA 25 Sea-Run Cutthroat Stocks**

Stock	Stock Origin	Production Type
Grays River	Native	Wild
Elochoman/Skamokawa	Native	Wild
Mill/Abernathy/Germany Creek	Native	Wild

Adapted from Blakley et al. 2000.

## HABITAT LIMITING FACTORS BY SUB-BASIN

This discussion of habitat limiting factors for Water Resource Inventory Area (WRIA) 25 and tributaries to the Columbia River in WRIA 24 includes information on three subbasins; the Grays River, Elochoman/Skomokawa, and Abernathy/Mill/Germany Subbasins (See Map A-2). These subbasins were further divided into smaller watersheds to provide additional detail available from stream surveys conducted by the Cowlitz and Wahkiakum Conservation Districts. Data on tributaries to the Columbia River in WRIA 24 is included in the Grays River Subbasin. WRIA 25 Technical Advisory Group (TAG) members added their personal knowledge on habitat conditions within these subbasins.

### Grays River Subbasin

To facilitate collection and reporting of habitat conditions, the Grays River subbasin was delineated into its principal watersheds. Detailed information is provided for each of these principal watersheds. When necessary the watershed was further delineated into subwatersheds. The following list details the watersheds and subwatershed areas delineated for reporting (in bold) and the tributaries that they encompass.

- **Chinook River Watershed (WRIA 24)**
- **Grays Bay Tributaries:**
- **Deep River Watershed:** (Campbell, Lassila, Salme, Hendrickson, and Person Creeks and Rangilla Slough)
- **Sisson Creek Watershed;**
- **Crooked Creek Watershed:** (South Fork Crooked Creek and tributaries)
- **Grays River Watershed:**
- **Lower Grays River to Covered Bridge:** (Seal, Malone, Hull, Honey, Fall, Impie, Nikka, Thadbar, and Kessel Creeks and Seal Slough);
- **Grays River Covered Bridge to Canyon:** (King, Klints, and Fossil Creeks and Unnamed tributary, Crazy Johnson)
- **West Fork Grays River:** (Beaver, Shannon, and Sneigiler Creeks, and an unnamed tributary)
- **South Fork Grays River:** (Blaney Creek and its tributary)
- **Upper Grays River from Canyon to headwaters:** (East Fork Grays River and its tributaries, and Alder, Cabin, Johnson, and Unnamed Creeks)

### Habitat Limiting Factors in WRIA 24 Tributaries

All tributaries to the Columbia River in WRIA 24 were also included in this report (see Map A-2 in Appendix A). The major watersheds in this area include the Chinook and Wallacut Rivers. In general, data on habitat conditions and fish distribution was only available for the Chinook River. The other stream systems are smaller tributaries that have limited spawning area for salmon and steelhead. The following discussion details what information is available for the area.

### *Access*

- Tidegates on the Wallcut River under Stringtown Road may block passage at certain flows. These potential barriers need assessment.
- TAG members thought that the tidegates on the Chinook River under Highway 101 restrict passage during certain flows. These tidegates alter water exchange rates and tidal influences that may create thermal and dissolved oxygen barriers under certain conditions (TAG). These tidegates are slated for removal or replacement with tidegates that will not inhibit passage.
- The City of Chinook's water supply dam restricts passage on Freshwater Creek, blocking approximately ½ mile of potential anadromous habitat.
- Sea Resources places a weir in to restrict passage of hatchery fish into upstream habitats from mid-September to late November. Hatchery staff randomly selects from hatchery and native brood stock for the hatchery, and a mix of natural and hatchery fish are passed above the hatchery. After late November, all fish have unlimited access to upstream habitats.
- The intake dam for the hatchery does not create a passage problem (TAG).
- Some of the smaller tributaries to the Columbia in WRIA 28 upstream of the Chinook River may provide potential spawning and rearing habitat. However, there is limited information on passage and habitat conditions. The conditions in these streams need assessment.

### *Floodplain Connectivity*

Dikes, dredging, the removal of logjams, and tidegates have altered floodplain connectivity along almost the entire lower reaches of the Chinook River (TAG; Dewberry 1997). According to Dewberry (1997), "In 1805, Lewis and Clark reported that the Chinook River was 300 yards wide at high tide." The valley floor between the Chinook and Wallcut Rivers consisted of lowland marsh with numerous ponds (Dewberry 1997). Connections to floodplain habitats have been substantially altered since then.

Above tidal influence (RM 2.5) to the hatchery (RM 4), diking occurs along approximately 1/3 of the channel length. Some of the stream channel within this reach is also incised. From the hatchery intake to the headwaters, approximately 40% of the channel is noticeably incised within a wide valley (TAG).

Sea Resources has partnered with Ducks Unlimited, the Columbia Land Trust, the NRCS, and USFWS to begin restoring estuarine function in the lower Chinook River. The ultimate goals of the restoration projects are to restore 80% of the original Chinook River estuary habitat to historic conditions and to increase tidal flushing. Grants have been obtained to purchase and restore approximately 1,100 acres of estuarine wetlands, and to remove or replace the existing tide gates with gates that will allow fish passage during all flows and improve tidal flushing ([www.searesources.org](http://www.searesources.org); Columbia Land Trust 2000: SRFB Grant application).

Data is lacking on floodplain conditions for other tributaries to the Columbia River in WRIA 24.

#### *Bank Stability*

Historically, the tidally influenced lower reaches of the Chinook River consisted of a series of highly dynamic channels, marshes, and ponds (Dewberry 1997). The Conservation Commission's bank stability ratings would not apply in this type of dynamic system. Diking and dredging over the years has maintained a single stable channel to benefit landowners, but that has considerably reduced channel complexity and available habitat. TAG members noted that cattle have access to a number of reaches of the lower Chinook River; likely impacting bank stability in these areas (TAG).

Data on bank stability conditions is lacking for most of the Chinook River and other streams within WRIA 24. TAG members familiar with the Chinook River considered bank stability "good" from the end of tidal influence to Sea Resources Hatchery. Reed canary grass covers the streambanks along much of this reach, preventing bank erosion. From the hatchery to the headwaters, TAG members noted that some bank erosion is occurring, and that conditions are probably in the "fair" range.

#### *Large Woody Debris (LWD)*

Historically, large accumulations of large woody debris (LWD) were found throughout Baker Bay and the lower Chinook River, few such accumulations exist today (Dewberry 1997). Riparian conditions are poor along almost all reaches of the Chinook River and its tributaries, resulting in limited LWD recruitment to downstream habitats. Tidegates also restrict any upstream LWD movement from the Columbia River into the Chinook River estuary.

Riparian trees (Sitka spruce, red cedars, and alders) in the state park and along a few reaches in the upper watershed would provide the only significant potential source of future LWD. The majority of the remaining riparian vegetation includes alders, young conifers, and reed canary grass.

Data on LWD levels in the other streams of WRIA 24 is lacking. TAG members considered LWD levels "poor" in the Wallacut River, Eagle Creek, Freshwater Creek, and Kallstrom Creek.

#### *Percent Pool*

There is also little information on pool habitat conditions in any of the WRIA 24 streams. The lower reaches of the Chinook and Wallacut Rivers are low gradient, tidally influenced reaches where rating standards for percent pool would not apply. From the end of tidal influence to the hatchery on the Chinook, TAG members considered pool frequencies good, but noted that the quality of pools needs improvement. From the hatchery to the headwaters percent pool and pool quality was considered fair. Beavers play a large role in producing and maintaining pool habitat in the upper reaches of the Chinook River.

Pool habitat conditions are unknown for other tributaries in WRIA 24 that feed into the Columbia.

#### *Side Channel Availability*

Historically, the lower reaches of the Chinook River contained a large interconnected series of dendritic channels and sloughs. Diking, dredging, and filling have eliminated connection to most of these historic channels (Dewberry 1997). From tidal influence to the hatchery, some side channel habitat exists but not to historic levels. Above the hatchery, side channel availability was considered poor. Beavers create most of the side channel habitat in this reach.

Data on side channel habitat is lacking for other tributaries within WRIA 24 tributaries to the Columbia River.

#### *Substrate Fines*

Data is also lacking on substrate conditions within the WRIA 24 Columbia River tributaries. In the 1970's, an extensive road network was built in the upper Chinook River basin and most of the watershed was logged. Over 30 large landslides and debris torrents are evident in 1974 aerial photos. These moved a tremendous amount of sediment into the stream channels and estuary (Dewberry 1997). TAG members noted that debris torrents and road culvert failures are still contributing to sediment loads in the basin, but that the extent of these problems is unknown and needs assessment. Recreational vehicles (ATVs) are also contributing to fine sediment loads in the Chinook River basin (TAG).

The tidally influenced reaches of the Chinook and Wallacut have a naturally high percentage of fine substrates. Above the tidal reaches to the hatchery, TAG members noted that excessive substrate fines are likely a continuing problem. Chum spawning occurs in this area, with other species generally spawning above the hatchery. From the hatchery to the forks of the Right and Left Branch, are the major spawning grounds for coho and chinook salmon in the Chinook River (Dewberry 1997). TAG members noted that there were areas with good substrate conditions in this reach, but that overall substrate conditions would probably fall in the fair category. TAG members noted that Kallstrom Creek has larger substrates and less fine sediment than Freshwater Creek. However, the specific substrate conditions in these streams are unknown.

Data is also lacking on substrate conditions for other tributaries to the Columbia in WRIA 24. One TAG member noted that Eagle Creek has some good spawning substrates in the lower reaches.

#### *Riparian Conditions*

According to Dewberry (1997), "Historically, large conifers (primarily Sitka spruce, western hemlock, and western red cedar) dominated the valley floor of the Chinook basin. This is in contrast to the uplands, where patches of mature conifers existed within

a mosaic of younger classes. In 1805, Meriwether Lewis and William Clark reported numerous conifer trees larger than 3-feet in diameter growing on the downed logs at the mouth of the Chinook River. Big trees were cut from the stream-side zone – and big logs cleared from the stream channel – in the early decades of settlement.” Today, riparian conditions are poor along most reaches of the Chinook River and its tributaries (TAG; Dewberry 1997). In the 1970’s most of the upper Chinook River basin was logged down to the streams (TAG). Some of the areas were replanted and young conifers are growing. However, most of the riparian areas still contain a high percentage of either deciduous species or reed canary grass.

Currently, the valley floor of lower Chinook River is sparsely developed and mostly agricultural. Riparian restoration is needed along most of the lower river (TAG). A small reach along the State Park has good riparian conditions, but the rest of the area between tidal influence (RM 2.5) and the hatchery (RM 4) has poor riparian conditions, dominated by either young deciduous trees or reed canary grass. A mix of deciduous trees and young conifers cover the riparian corridors from the hatchery to the headwaters (TAG). Good riparian conditions occur along some of the upstream reaches of Kallstrom Creek.

Riparian conditions are unknown for most of the other streams feeding the Columbia River in WRIA 24. TAG members did note that the Wallacut River has almost no riparian cover.

#### *Water Quality*

Water quality data is lacking for most of the streams that feed the Columbia in WRIA 24. Some initial water quality monitoring in the Chinook River found water temperatures as high as the mid-70° F just above the tidegates. Water temperatures have not exceeded 60° F in the last two years of monitoring at the hatchery (TAG). There is some organic loading to the Chinook River from the hatchery operation; however initial dissolved oxygen (DO) measurements found that DO was similar above and below the hatchery. TAG members noted that turbidity may be a problem in the upper reaches of the Chinook, but specific data is lacking. TAG members suspect that elevated water temperatures may also be a problem in the Wallacut due to the very low flow conditions during the summer months.

Sea Resources is developing a water quality monitoring program for the Chinook River that should provide better data on water quality issues in the watershed.

#### *Water Quantity*

Data on water quantity is also lacking for the streams that feed the Columbia River in WRIA 24. Hydrologic maturity should be improving for the Chinook River system with the re-growth of the forest after extensive logging in the 1970’s (TAG). However, the high road density and loss of forest cover has likely increased peak flows above historic levels.

Low flows are a natural condition for the rain and groundwater fed streams within WRIA 24. Streams, such as the Wallacut River, have minimal flow during summer months. Sea Resources Hatchery diverts water for its operations from the Chinook River approximately 0.6 miles upstream. However, this water is diverted back into the river below the hatchery, and TAG members felt that the withdrawals had minimal impacts on streamflow. The City of Chinook also withdraws water from Freshwater Creek for its water supply. The extent of the impacts from these withdrawals is unknown, but TAG members noted that these withdrawals might be impacting fish habitat in downstream reaches.

### *Biological Processes*

The Conservation Commission is using the number of stocks meeting escapement goals as a surrogate measurement of nutrient levels within stream systems (see Appendix B). WDFW has not set escapement goals for any stocks of salmon or steelhead for any of the streams that drain into the Columbia River in WRIA 24. Escapement for most anadromous stocks in the Chinook River basin is likely well below historic averages, and the lack of carcasses contributing nutrients to the systems may be limiting production within the subbasin. By 1900, the fish trap operators were harvesting up to 12,000 pounds of salmon from the mouth of the Chinook River per day, making the town of Chinook the wealthiest town per capita in the United States ([www.searesources.org](http://www.searesources.org)). According to Dewberry (1997), “it is likely that the fall chinook in the Chinook River could not run the gauntlet of seines and fish traps in Baker Bay, and that there has been no significant fall chinook spawning in the basin for about a century”. The number of coho, winter steelhead, and chum salmon entering the Chinook to spawn is also likely well below historic number. Bryant (1949) estimated that the Chinook River could accommodate about 1000 pairs of salmon. Returns to the hatchery in 2000 included 53 chinook, 154 coho, and 18 chum salmon ([www.searesources.org](http://www.searesources.org)).

All salmon and steelhead returning to Sea Resources Hatchery are either passed above the hatchery to spawn or their carcasses are distributed in upstream habitats.

Other introduced species impact biological processes in the Chinook River and the other tributaries to the Columbia River in WRIA 24. Reed canary grass is a large problem in many areas of the Chinook and Wallacut Rivers. Warm water predators have prospered in the lower reaches of the Chinook where tidegates have influenced water temperatures, streamflow, and tidal flushing (TAG). Exotic species, such as spiny ray fishes (largemouth bass and bluegill), and European carp present a significant predatory threat to rearing and migrating salmonids in the lower Chinook River ([www.searesources.org](http://www.searesources.org); Dewberry 1997). One bass was captured recently with six salmon smolts in its stomach.

### Grays Bay Tributaries

The Grays Bay tributaries include the Deep River Watershed with its tributaries (Campbell, Lassila, Salme, Hendrickson, and Person Creeks and Rangilla Slough), the Crooked Creek watershed, and the Sisson Creek Watershed.

### *Access*

Tidegates have been installed on a number of tributaries and sloughs that connect to Grays Bay. Almost all of these tidegates need assessment to determine if they restrict or reduce fish passage. Map A-2 in Appendix A, shows the known and potential barriers identified during the LFA process including tidegates, culverts, dams, and natural barriers. In Deep River, several tidegates under Deep River Loop Road were replaced recently. TAG members thought the replacement gates had fixed fish passage problems in lower Deep River. Low flow conditions may limit access into Deep River; however, TAG members indicated that low flows were a natural occurrence in the watershed. There are no known barriers in the Sisson Creek watershed.

On Crooked Creek, stream surveys terminated at RM 7 due to a 30' cascade greater than 30% slope. The South Fork Crooked Creek has a 15-foot falls at RM 1.2. Surveys were ended on all of the tributaries to the South Fork due to falls or extremely steep gradient cascades that were thought to prevent fish passage.

According to Bryant (1949), below the forks on Crooked Creek (RM 4) there was an irrigation dam, 4 feet high, that formed a low water barrier. An old unused power dam was located 600 yards up the North Fork (Bryant 1949). Stream surveyors did not note the irrigation dam but did identify a dam on an unnamed tributary to the North Fork. The dam is located near the mouth of the tributary and the tributary is located approximately 600 yards above the confluence of the North and South Forks.

### *Floodplain Connectivity*

Data was lacking for floodplain connectivity for most of the Grays Bay tributaries. The lower reaches of Deep River (RM 0 to 3.9) have been diked (TAG, WCD 2001). Tidal influence reaches approximately 5,000 feet upstream in Deep River. Tidegates have been installed on several other tributaries to Grays Bay (TAG). Information is lacking on the exact location of all these potential barriers, and on the effect these tidegates have on floodplain connectivity and function. The Conservation District stream surveys did not measure entrenchment ratios along any of the stream segments of Grays Bay tributaries.

Crooked Creek has been channelized throughout the lower 2 miles and is considered highly entrenched (WCD 2001).

### *Side Channel Availability*

Conservation District stream surveys noted side-channel habitat on most surveys forms. Stream surveyors noted little or no side channel habitat in all surveyed reaches of the Deep River watershed. The lower segments of most Grays Bay tributaries are diked and tidegates limit connectivity to tributary streams (TAG). In the upper segments of Deep River, extensive stream channelization for agricultural purposes limits side channel development (WCD 2001). Data was lacking for side channel availability in the Sisson Creek watershed.

Side channel availability is considered “poor” throughout Crooked Creek (TAG). In the lower reaches, extensive stream channelization for agriculture limits side channel development. Although limited in number, side channels were observed in a few of the stream segments surveyed on the mainstem Crooked Creek.

### *Bank Erosion*

(Map A-12)

Wahkiakum Conservation District stream surveys identified areas where bank erosion was occurring outside of those areas where erosion is expected, such as on outside bends, areas where the channel is constricted, or areas where flow is deflected into a bank by local conditions (see Appendix D for stream survey protocol). The data from these stream surveys was used to identify the percentage of streambanks exhibiting streambank erosion within each 1000-foot stream survey reach. This percentage was compared with the percentages for bank stability provided by the Commission guidelines to establish “good”, “fair”, and “poor” ratings for bank erosion. In reviewing Map A-12, developed from the stream survey data, many TAG members stated that the data and the Bank Erosion Map A-12 underestimated the extent of bank instability and erosion occurring within many of the watersheds in WRIA 25. TAG members noted that mass wasting was a major problem in many areas of the Grays River watershed. However, the stream survey data does provide a snapshot of erosion problems areas during the period of the stream survey work.

Bank erosion was estimated from the stream survey data for both banks in every 200-foot segment in 5 percent increments. The length of actively eroding banks was compared to the 400 feet of total stream bank in the segment. Only the ordinary high water zone was considered (WCD 2001).

Table 28 lists bank erosion conditions for the Grays Bay tributaries. Actively eroding banks were noted during stream surveys conducted in 1994. Stream surveys did not identify any actively eroding streambanks in surveyed reaches of Deep River. The lower reaches of Deep River are diked and subsequently protected from erosion. Many of the tributary streams had been relocated and hardened in the past to maximize the amount of floodplain available for agriculture use (TAG). However, all surveyed reaches of Ragilla, Anderson, and Person Creeks had extensive bank erosion problems (see Table 28). Stream bank erosion in the lower reaches of Person Creek (RM 8.6 of Deep River) averaged 60-80 percent (WCD 2001).

Approximately 74% of the surveyed reaches of Hendrickson Creek rated “good for bank erosion. However, stream surveyors observed that the lower reaches of Hendrickson Creek (RM 6.9 of Deep River) had moderate erosion occurring in the lower reaches with localized problems where streambank erosion reaches as high as 80%. Even during a period of no rainfall, stream surveys noted that Hendrickson Creek was flowing cloudy. The source of turbidity was never located as it originates above the point where stream

surveys ended. Stream surveys found that over 86% of South Fork Crooked Creek, over 80% of Crooked Creek, and almost 74% of Sisson Creek rated “good” for bank erosion.

Bank erosion problems were identified in the lower reaches of Crooked Creek and three of the 48 surveyed reaches rated “poor”. The segments with bank erosion problems are all low gradient, highly meandering, and unconfined channel with limited riparian vegetation flowing through alluvial floodplains. Bank erosion concerns diminished in the upper reaches of Crooked Creek including the North Fork, South Fork, and their tributaries (WCD 2001).

**Table 28: Grays Bay Tributaries Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Anderson Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Crooked Creek	39	81.3%	1	2.1%	3	6.3%	5	10.4%	48	100%
Deep River	26	100.0%	0	0.0%	0	0.0%	0	0.0%	26	100%
Hendrickson Creek	5	71.4%	0	0.0%	2	28.6%	0	0.0%	7	100%
North Fork Deep River	0	0.0%	1	50.0%	1	50.0%	0	0.0%	2	100%
Person Creek	0	0.0%	0	0.0%	8	100.0%	0	0.0%	8	100%
Rangilla Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Sisson Creek	14	70.0%	1	5.0%	5	25.0%	0	0.0%	20	100%
South Fork Crooked Creek	19	86.4%	3	13.6%	0	0.0%	0	0.0%	22	100%
Total	103	45.4%	6	7.9%	25	45.5%	5	1.2%	139	100%

### *Substrate Fines*

(Appendix A, map A13)

Data on substrate conditions from stream surveys conducted by the Wahkiakum Conservation District is listed in Table 29. Surveys found that all of the Grays Bay tributaries had problems with excessive substrate fines. The lower reaches of most of these streams are low gradient and tidally influenced, and substrate fines naturally accumulate. Tidal conditions influence the accumulation of silt in Sisson Creek for approximately one mile. The upper segments were identified as low gradient reaches flowing through wetlands. In this area gravel accumulations are limited; however, as Map A-13 illustrates, there are some reaches in upper Sisson Creek where substrate fines rated “good” and “fair”.

Tidal conditions also influence the accumulation of silt in the mainstem Deep River. The lower segments of its tributary streams are extremely low gradient channels where the substrate is dominated by fine sediment. As stream gradient increases in the tributary streams gravel was observed but was noted as soft rock highly embedded with fines (WCD 2001). The surface geology in the area contains mostly near shore sedimentary

deposits. The rock that is delivered to the stream is weak and readily breaks down into sand and silt particles (WCD 1997).

**Table 29: Grays Bay Tributaries Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Anderson Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Crooked Creek	0	0.0%	1	2.1%	42	87.5%	5	10.4%	48	100%
Deep River	0	0.0%	0	0.0%	26	100.0%	0	0.0%	26	100%
Hendrickson Creek	0	0.0%	0	0.0%	7	100.0%	0	0.0%	7	100%
North Fork Deep River	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
Person Creek	0	0.0%	0	0.0%	8	100.0%	0	0.0%	8	100%
Rangilla Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Sisson Creek	3	15.0%	1	5.0%	16	80.0%	0	0.0%	20	100%
South Fork Crooked Creek	3	13.6%	2	9.1%	17	77.3%	0	0.0%	22	100%
Total	6	3.2%	4	1.8%	124	93.9%	5	1.2%	139	100%

Data from WCD 2001

The Crooked Creek watershed rated “poor” overall for substrate fines conditions. Fine sediment was noted throughout the system. The lower three miles of Crooked Creek is influenced by tides and fine sediments are the natural, dominant substrate. The lower reaches of the tributary streams are also extremely low gradient channels where fines dominate the substrate. As stream gradient increases in the tributary streams, gravel was observed but was noted as soft rock highly embedded with fines. The surface geology in the area is dominated by near shore sedimentary deposits. The rock that is delivered to stream is weak and readily breaks down into sand and silt particles (WCD 1997).

Wahkiakum Conservation District conducted an inventory of watersheds in Wahkiakum County in 1993 (Waterstrat 1994). They collected field data on animal density, animal access to streams, forest cover, and riparian conditions for major streams within Wahkiakum County. They also measured road densities and use, identified homes within 200 feet of streams, and noted the number of mass failures from the USDA Soil Survey maps. According to Waterstrat (1994), there are approximately 28.5 total miles of road in the Deep River watershed making an overall density of 4.44 miles of road/square mile. Road densities are used as a surrogate measurement of potential substrate fines problems within a watershed in the Conservation Commission’s Habitat Rating Standards (see Appendix B). This road density is well above the 3.0 miles of road/per square mile that falls in the “poor” category for substrate fines. Approximately 76% of the roads were not actively used during the 1993 surveys. Waterstrat (1994) measured 49 miles of road in the Crooked Creek watershed creating a road density of 4.12 miles/square mile. Only 28% of the roads were actively used.

Waterstrat (1994) also found that livestock had access to most of the stream reaches that they surveyed in the Deep River and Crooked Creek watersheds. Fences along riparian areas were not visible along 90% of the surveyed streambanks in Deep River, and animals had access to almost all surveyed reaches of Crooked Creek. TAG members also noted that livestock had access to parts of Crooked Creek.

There are a total of 30 and 75 mass failures noted on the 1986 USDA Soil Survey Map for Deep River and Crooked Creek respectively. These occur most frequently on Lytell silt loam with 30%-65% and 65%-90% slopes. The average frequency of mass failures throughout the entire Deep River and Crooked Creek watersheds were 4.67 and 6.25 mass failures/square mile respectively. Crooked Creek had the highest number of mass failures/mile of any watershed assessed in Wahkiakum County (Waterstrat 1994).

Lewis County GIS (2000) measured the number and percentage of roads within 200 feet of anadromous streams, the number of road-stream crossings per square mile, and road densities within the various Watershed Administrative Units (WAUs) of WRIA 25 using Lunetta et al. (1997) data. As Table 30 shows, there are over 44 miles of stream adjacent roads (within 200 feet of anadromous streams) within the WAU, and 16.6 stream crossings/mile. These stream adjacent roads and stream crossings likely contribute to fine sediment loads within the streams in the Grays Bay WAU (see Map A-19).

**Table 30: Road Conditions within the Grays Bay WAU**

WAU number	WAU name	Road miles outside 200' buffer	Road Miles in 200' buffer	Percent of Roads in buffer	Stream crossings per sq mile	Road density
250310	Grays Bay	372.3	44.6	10.7	16.6	4.346

from Lewis County 2000

#### Riparian Conditions (Appendix A, map A14)

Wahkiakum Conservation District conducted stream surveys between 1994 and 1996 on WRIA 25 streams. Areas with similar habitat characteristics delineated stream reach lengths. Riparian buffer width, percent composition, and diameter at breast height were measured and averaged for the reach on a weighted basis (see Appendix D). The width criteria and species composition was applied directly to the data set with one assumption. Diameter at breast height was used as a surrogate for “mature” under good riparian conditions. Sixteen (16 inches) inches was used as the diameter at which a conifer was deemed “mature”. This value corresponds with the minimum diameter for a log to be classified as a “key piece” of LWD.

Wahkiakum Conservation District stream survey data on riparian conditions is listed in Table 31. Riparian conditions vary considerably between the various Grays Bay tributaries. Riparian conditions, along two surveyed 1,000-foot reaches of the North Fork Deep River rated “good”. However, 24 out of 26 reaches (92.3%) on Deep River had “poor” riparian conditions. The lower two miles of the mainstem Deep River is mixed agriculture and forestland use. In the forested areas riparian conditions generally rated

“poor” due to the dominance of deciduous species and the relatively young age, yet the width of the riparian buffer was generally over 200 feet. Throughout the agriculture portion, riparian conditions were “poor” due to highly variable buffer widths (0-120 feet) and the dominance of relatively young, deciduous species. Most riparian corridors along the upper Deep River tributaries had better riparian conditions (WCD 2001).

Stream surveys determined that overall riparian conditions in the Crooked Creek watershed rated “poor”, although riparian conditions tended to improve in the upper reaches and some tributaries. The lower reaches rated “poor” due to inadequate riparian buffer widths and the dominance of deciduous species in areas of agriculture land use. Livestock access to streams also contributed to riparian problems. Forested segments generally received a “poor” or “fair” rating primarily because the predominant species were deciduous species and/or immature. In several stream segments in the upper watershed riparian conditions were rated “good” (WCD 2001).

**Table 31: Grays Bay Tributaries Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Anderson Creek	0	0.0%	2	66.7%	1	33.3%	0	0.0%	3	100%
Crooked Creek	1	2.1%	19	39.6%	23	47.9%	5	10.4%	48	100%
Deep River	0	0.0%	2	7.7%	24	92.3%	0	0.0%	26	100%
Hendrickson Creek	2	28.6%	2	28.6%	3	42.9%	0	0.0%	7	100%
North Fork Deep River	2	100.0%	0	0.0%	0	0.0%	0	0.0%	2	100%
Person Creek	0	0.0%	3	37.5%	5	62.5%	0	0.0%	8	100%
Rangilla Creek	0	0.0%	1	33.3%	2	66.7%	0	0.0%	3	100%
Sisson Creek	0	0.0%	9	45.0%	11	55.0%	0	0.0%	20	100%
South Fork Crooked Creek	8	36.4%	4	18.2%	10	45.5%	0	0.0%	22	100%
Total	13	18.6%	42	30.7%	79	49.6%	5	1.2%	139	100%

According to Waterstrat (1994), all of the current agricultural and/or residential development occurs on nine percent of the Deep River watershed. The lower end of the subbasin has reverted from a productive agricultural area to one with extensive tidal wetlands. Using different criteria than the Conservation Commission, Waterstrat (1994) estimated that approximately 51 percent of the riparian habitat along Deep River was in good condition. Based on field count the average animal density was estimated at 0.35 animals per acre, and fences to prevent animal access were not visible along over 90 percent of the stream banks. State, private, and industrial forest companies own over 91% of the land in the Deep River watershed; 30 percent of the forest cover is 50+ years old, 55 percent is 11-50 years old, and 15 percent is 0-10 years old (Waterstrat 1994).

The Sisson Creek watershed has 9 stream reaches with “fair” riparian conditions and 11 with “poor” conditions (see Table 31). There is an even mix of conifer and deciduous species in the lower segments, and deciduous tree species dominate the middle reaches. Although this stream does not have the percentage of conifer species required by the rating criteria, stream survey data indicates that the stream is well buffered with mature timber.

Waterstrat (1994) noted that only 11%-12% of the total stream length of Crooked Creek watershed had what they considered good riparian conditions. Wahkiakum Conservation stream surveys found even less good riparian habitat along the mainstem Crooked Creek, but they found 36.4% “good” riparian habitat along the South Fork Crooked Creek (WCD 2001). Waterstrat (1994) also found that only 1% of the commercially owned timber in the watershed is > than 50 years.

#### *Large Woody Debris (LWD)*

(Appendix A, map A15)

Wahkiakum Conservation District stream surveyors found very little large woody debris (LWD) in any of the Grays Bay tributaries (see Table 32). LWD rated “good” along only a small percentage of the surveyed reaches within Crooked Creek and South Fork Crooked Creek. Almost 90% of all surveyed reaches of Grays Bay tributaries rated “poor”. Deep River LWD rated “poor” almost throughout the watershed. While all reaches of Hendrickson Creek rated “poor” for LWD, stream surveyors noted numerous logjams and small diameter red alder logs in the stream.

In Sisson Creek, the LWD observed consisted primarily of deciduous species, which is consistent with the dominant riparian species along the creek. Surveyors noted a large logjam at RM 3 on Sisson Creek that they considered impassable (WCD 2001).

**Table 32: Grays Bay Tributaries Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Anderson Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Crooked Creek	3	6.3%	3	6.3%	37	77.1%	5	10.4%	48	100%
Deep River	0	0.0%	0	0.0%	25	96.2%	1	3.8%	26	100%
Hendrickson Creek	0	0.0%	0	0.0%	7	100.0%	0	0.0%	7	100%
North Fork Deep River	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
Person Creek	0	0.0%	0	0.0%	8	100.0%	0	0.0%	8	100%
Rangilla Creek	0	0.0%	0	0.0%	2	66.7%	1	33.3%	3	100%
Sisson Creek	0	0.0%	0	0.0%	19	95.0%	1	5.0%	20	100%
South Fork Crooked Creek	3	13.6%	2	9.1%	16	72.7%	1	4.5%	22	100%
Total	6	2.2%	5	1.7%	119	89.7%	9	6.3%	139	100%

LWD levels in the Crooked Creek watershed rated “poor”. Where surveyors encountered LWD, it generally consisted of deciduous species. Several logjams anchored by old growth logs were observed in the South Fork Crooked Creek (WCD 2001).

Percent Pool (Appendix A, map A16)

Where the data was available for the Grays Bay tributaries, the percentage of pool habitat was generally “poor” according to the Conservation Commissions habitat rating standards (see Appendix B and Table 33). The poor percent pool rating for many of the surveyed reaches is due partially to extensive tidal influence and low gradient channels. The lower segments of Sisson Creek are tidally influenced and subsequently rated “poor” for pool frequency. However, stream surveys determined that the middle segments have a “good” percentage of pool habitat, up to 60 percent. The upper segments and an unnamed tributary to Sisson Creek rated “fair” for percent pool. No information is available regarding the quality of these pools.

The mainstem Deep River is largely a tidally influenced, low-gradient system where the percent pools criteria does not apply. Stream segments where the gradient increases on three tributary streams, Anderson, Hendrickson, and Person Creeks, generally rated “fair” or “good” for percent pool.

The percentage of pool habitat in the mainstem Crooked Creek rated “poor” overall (see Table 33). The first 2 miles are tidally influenced and stream surveys did not observe any pools. The majority of surveyed reaches in the South Fork Crooked Creek also rated “poor” for percent pools.

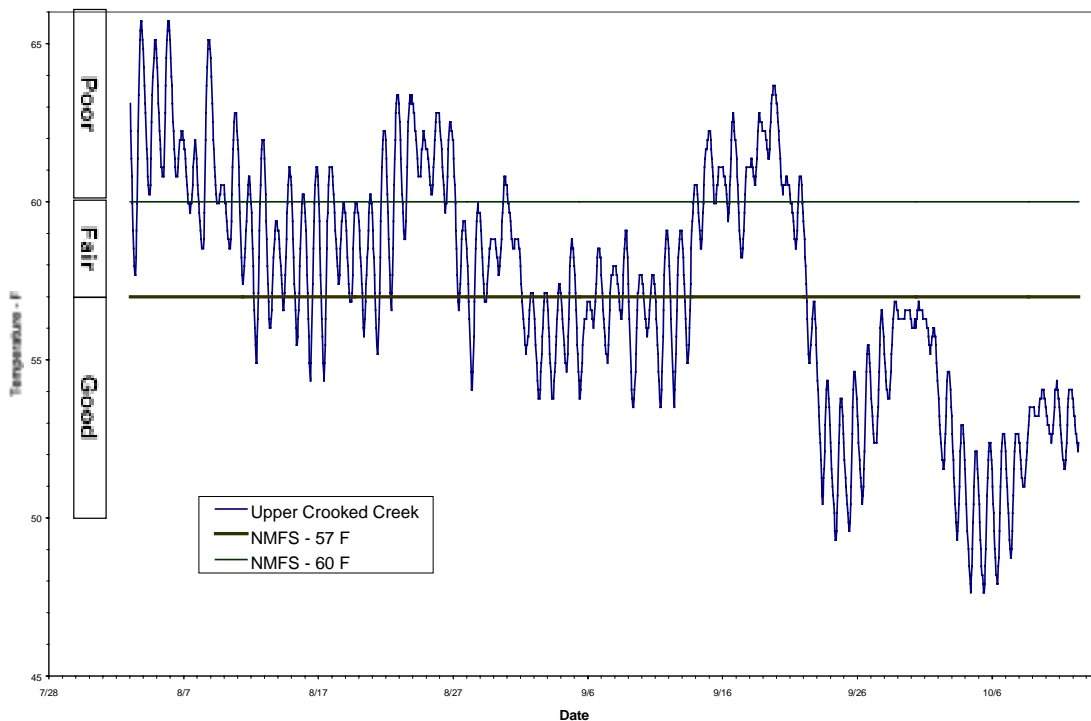
**Table 33: Grays Bay Tributaries Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Anderson Creek	0	0.0%	1	33.3%	1	33.3%	1	33.3%	3	100%
Crooked Creek	3	6.3%	2	4.2%	32	66.7%	11	22.9%	48	100%
Deep River	0	0.0%	0	0.0%	24	92.3%	2	7.7%	26	100%
Hendrickson Creek	1	14.3%	2	28.6%	1	14.3%	3	42.9%	7	100%
North Fork Deep River	0	0.0%	0	0.0%	0	0.0%	2	100.0%	2	100%
Person Creek	0	0.0%	1	12.5%	3	37.5%	4	50.0%	8	100%
Rangilla Creek	1	33.3%	0	0.0%	2	66.7%	0	0.0%	3	100%
Sisson Creek	5	25.0%	4	20.0%	11	55.0%	0	0.0%	20	100%
South Fork Crooked Creek	3	13.6%	7	31.8%	12	54.5%	0	0.0%	22	100%
Total	13	10.3%	17	14.5%	86	46.7%	23	28.5%	139	100%

### Water Quality

Data was generally lacking for water quality on the Grays Bay tributaries. Beginning in 2000 the Wahkiakum Conservation District started to monitor the temperature in Crooked Creek. Monitoring is planned annually through 2004. Figure 2 illustrates the temperature data obtained from Crooked Creek during the summer of 2000. The two horizontal lines in Figure 2 represent Washington State Conservation Commission water temperature criteria for salmon spawning (see Appendix B). The state water quality standard for Type A waters is 64.4 ° Fahrenheit. Stream temperatures increase in Crooked Creek during the summer months when it can become a problem for resident fish and rearing salmonids. There was a 5-day period in early August where even minimum temperatures exceeded 60° F. Elevated summer water temperature may be a combined effect of a rain-dominated system, low flows, and lack of streamside vegetation (shade). Water temperatures begin to decrease rapidly with the onset of fall freshets and reach “good” conditions during the majority of salmonid spawning periods. Coho salmon may contend with temperatures in the “fair” to “poor” range as they first enter the system.

**Figure 2: Crooked Creek - Year 2000 Hourly Maximum Stream Temperatures**



Stream surveyors noted unusual turbidity in Hendrickson Creek during summer months. This turbidity appears to be associated with mass wasting in the upper watershed (TAG).

### *Water Quantity*

Data was generally lacking on water quantity (both low and potential peak flows) for any of the Grays Bay tributaries. The Washington Department of Ecology (Caldwell et al. 1999) conducted an instream flow study on a number of streams within WRIA 25 during the late summer and early fall of 1998 using the Toe-Width method. Toe width flows (a way of developing relationships between stream flows and fish habitat requirements) were calculated for a number of tributaries in WRIA 25 including, Grays River, Elochoman River, Coal Creek, Germany Creek, Abernathy Creek, Mill Creek, Crooked Creek and Wilson Creek.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Spot flow measurements were taken for all of the study streams except the Grays River and Elochoman River in the fall of 1998.

Comparisons of the optimum toe width flows in Crooked Creek (Table 34) with the spot flow measurements (Table 35) indicate that flow levels in October and November were near optimal for rearing. Flows approached optimal for coho spawning (9.1 c.f.s.) by October.

**Table 34: Toe-Width Flows for Grays Bay Tributaries**

Stream Name	Tributary to	Average Toe Width (in feet)	Toe-Width Flow for Fish Spawning and Rearing (in cfs)					
			Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
<b>Crooked Creek</b> (nr Eden Ln @ Rd crossing)	Columbia River	8.5	19.3	9.1	19.3	18.6	3.4	3.0

Adapted from Caldwell et al. 1999

**Table 35: Spot Flow Measurements for Grays Bay Tributaries**

Date	9/15/98	10/13/98	11/9/98
<b>Crooked Creek</b> (nr Eden Ln @ Rd crossing)	0.6 cfs	2.4 cfs	8.9 cfs

Adapted from Caldwell et al. 1999

Substantial changes from historic conditions have occurred in the land cover of the Grays Bay Watershed Administrative Unit (WAU). Table 36 provides land cover data that was originally derived from 1988 Landsat Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 36 that over 67% of the land cover in the subbasin is now in early seral stages, non-forest and other uses. Subsequently, streams within the subbasin likely experience increased magnitude,

duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). High road densities increase channel lengths and direct overland flow directly to streams, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. As Map A-17 and Table 36 illustrate, over 67% of the forest cover in the Grays Bay WAU is considered hydrologically immature and road densities exceed 3 miles/square mile, raising concerns for increased peak flows in streams in this area.

Waterstrat (1994) analyzed land cover and land uses within many of the watersheds in Wahkiakum County. They found that approximately 9% of the Deep River watershed is in agricultural land use, and the remaining 91% is in commercial forestry. Interpretation of 1990 aerial photos determined that approximately 31% of the commercial forestry ground in the Deep River watershed had timber >51 years old; 55% of the timber was between 11 and 50 years old; and 15% of the timber was 10 years old or less (Waterstrat 1994). High road densities in the Deep River (4.44 miles of road/square mile) likely extend the drainage network in the watershed, potentially contributing to increased peak flows (see Table 36 for additional data). Tag members also noted that Deep River has low-flow problems as most of the tributaries dry up during the summer months.

Approximately 89% of the Crooked Creek watershed was in commercial forestry (Waterstrat 1994). Interpretation of 1990 aerial photos determined that only 1% of the commercial forestry ground in the Crooked Creek watershed had timber >51 years old; 92% of the timber was between 11 and 50 years old; and 7% of the timber was 10 years old or less (Waterstrat 1994). Considering the high percentage of timber between 0 and 50 years old (99%) in the watershed and the high road density (4.14 miles of road/square mile), elevated peak flows may a problem in the Crooked Creek watershed.

**Table 36: Forest Seral Stage/ Land Cover in Gray Bay WAU (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
Grays Bay	Acres	944	8615	5489	9032	4602	28194	56875
	Percent	1.7	15.1	9.7	15.9	8.1	49.5	100.0

From Lunetta et.al. 1997

### *Biological Processes*

Data on various biological processes is generally lacking. Likely, historic escapement was considerably larger than present day. SASSI (WDF et al. 1993) considers Grays River chum, coho, and winter steelhead depressed stocks.

The Lower Columbia Fish Enhancement Group worked with local landowner Walt Cato to initiate a net-pen rearing project immediately downstream of the town of Deep River. In 1994, 50,000 fall chinook were raised and released at the site. In 1995, WDFW initiated a coho net pen rearing project below State Route 4 as a terminal fishery. In subsequent years, these two projects merged into one, managed by WDFW. The last report indicates that 200,000 coho were being raised and released at the site (LCFEG 2001).

### Lower Grays River to Covered Bridge

(including Seal Slough, Seal River, Malone Creek, Hull Creek, Honey Creek, Fall Creek, Impie Creek, Nikka Creek, Thadbar Creek, and Kessel Creek)

### *Access*

(Appendix A, Map A2)

Excessive sediment deposition near the mouth of the Grays River and in Grays Bay was identified by the TAG as a potential concern for fish passage. Low flows and shallow water may slow upstream migration and expose juveniles to high predation rates. This condition needs assessment.

The flow in lower end of Seal River occasionally ceases during summer months, affecting fish passage into the system. TAG members reported that the culvert on Malone Creek under State Route #4 creates problems because it does not have the capacity to convey high flows and it may limit passage for juvenile fish. Washington Department of Transportation (2001: personal comm.) indicated that the culvert was surveyed and was not placed on their priority list for fish passage. TAG members also indicated that lower Seal Creek was dredged periodically in the past to maintain drainage.

The lower Grays River to the Covered Bridge and its tributaries have various culvert, low flow, and tidegate concerns. Three specific problem areas were identified including:

- Impie Creek has a tidegate in the lower reaches that may block fish passage and needs assessment. There is approximately 1.7 miles of habitat above the tidegate (see Map A2)
- Wahkiakum County's culvert on Nikka Creek is scheduled for replacement in the summer of 2001. This culvert is considered a complete fish passage barrier, with 0.9 miles of habitat above the blockage.
- Wahkiakum County's culvert on Thadbar Creek is scheduled for replacement in the summer of 2001. This culvert is also considered a complete fish passage barrier, with 1.1 miles of habitat above the blockage.

- Three natural and two man-made barriers were identified in the Hull Creek drainage. A bedrock cascading falls on Hull Creek (RM 3) was retrofitted by WDFW with a fishway. This fishway has not been maintained and it has subsequently failed, blocking 1 mile of potential habitat (TAG). The other Hull Creek natural barrier is a falls at RM 7 that blocks upstream passage.
- Silver Creek, a tributary to Hull Creek, had a culvert that was  $\frac{3}{4}$  plugged and functioning improperly during 1994 stream surveys.
- Fall Creek, another tributary of Hull Creek, has a natural falls  $\frac{1}{3}$  mile from its mouth. Additionally, Fall Creek has culvert problems above the falls with a log jam at the upper end of culvert.

#### *Floodplain Connectivity*

The mainstem Grays River is diked to the Altoona Bridge (RM 4). The Army Corps of Engineers constructed most of the dikes. In conjunction with diking efforts, a large portion of the mainstem Grays River was armored (TAG). The lower 0.2 miles of Impie Creek has also been diked.

Many of the tributary streams in this reach of the river have been channelized, and streams were often routed along the toe of the surrounding hillslopes to increase the amount of contiguous pasture (WCD 2001). Typically, the streams were also entrenched and sub-surface drainage systems were often installed in pastures to facilitate drainage. Managed tributaries include Impie Creek, Thadbar Creek, Nikka Creek, and Seal River. Although it appears to have escaped management, Hull Creek is highly incised throughout the lower reach where agriculture is the predominant land use (WCD 2001).

Columbia Land Trust (2000) is working on acquisition and restoration projects near the mouth of Grays River that will serve to restore floodplain connectivity. The projects propose to acquire 202 acres of wetlands and associated uplands in Grays Bay; acquire and restore 200 acres of floodplain in Grays River at Devils Elbow; and acquire 125 acres of Grays River floodplain in Eden Valley. Overall, the project will preserve over 500 acres and restore tidal function to 200 acres of the Gray River estuary (Columbia Land Trust 2000).

#### *Side Channel Availability*

The mainstem Grays River is diked along most of this reach, limiting side channel development. Many tributary streams in this reach, including Seal Creek, Malone Creek, Impie Creek, Nikka Creek, Thadbar Creek, and Kessel Creek, are predominantly single thread channels where no side channels were observed during stream surveys (WCD 2001). Stream surveys did find side channels in most of the upper segments of Hull Creek and its tributaries. Stream surveyors observed that these side channels were generally short in length (30-150 feet in length) and predominantly overflow channels that are transient in nature.

### *Bank Erosion*

(Appendix A, Map A12)

Table 37 and Map A-12 provide data on stream bank erosion from Wahkiakum Conservation District stream surveys. Active bank erosion was estimated for every 200-foot segment in 5 percent increments during the surveys. The estimated erosion was calculated by determining the length of the eroding area, both sides of the stream, compared to the 400 feet of total stream bank in the segment. The information collected during the stream surveys does not meet the Conservation Commission's criteria for bank stability since erosion that occurred on outside bends, in areas where the channel was constricted, or where flow was deflected into a bank by local conditions was not noted in the surveys. Only those eroding areas in unexpected locations along straight areas and inside corners were noted. TAG members felt that this survey data is likely best used to identify areas where additional stream stability assessment is needed rather than an accurate picture of streambank stability in the watershed.

The tidally influenced area of the Grays River is diked and subsequently protected from erosion. However, TAG members indicated there are localized areas of the dike that are severely eroded, threatening private ownership and public facilities (roads). The lower reaches of Seal River are tidally influenced and erosion problems were limited to one of the six one thousand-foot survey segments where erosion on 40 percent of the stream banks was observed. Significant stream bank erosion (60%) was observed in Malone Creek on two of the six thousand-foot surveyed segments (see MapA-12).

The lower 4,000 feet of Impie Creek streambank erosion rated "good", while the upper 300 feet had "poor" streambank erosion (WCD 2001). The lower 4,000 feet of Impie Creek is predominately agriculture land use with limited livestock access, while the upper reaches are predominately forested.

Along the majority of surveyed stream segments in Nikka Creek bank erosion rated "good" (see Table 37). The predominant land use in the lower 3,000-feet is agriculture and livestock has access to a majority of the creek. Stream surveys noted erosion where livestock frequented the creek for water and in areas consistently used as crossings (WCD 2001). A failed culvert in the upper watershed has contributed to erosion problems in the area. The failure scoured out the stream below the crossing. Large woody debris in the stream minimized the impact to the streambanks and channel upstream of the crossing.

Bank erosion problems occur in the lower 5,000 feet of Thadbar Creek and associated tributaries. A majority reaches of the surveyed reaches (8 out of 12) had bank erosion problems (see Table 37). Stream surveys noted that this area contains alluvial (water deposited soil) floodplains, that agricultural land use predominates with livestock access to a majority of the stream, and that the stream is moderately entrenched. A failed road culvert was noted at the upper extent of the bank erosion problems that likely influenced down stream characteristics. The upper-forested reaches are in generally good condition

with the exception of one tributary where sixty percent of the stream banks showed signs of active erosion. The majority of Kessel Creek's surveyed stream reaches fell into the "good" category for bank erosion (see Table 37).

The majority of Hull Creek's surveyed stream reaches fell into the "good" category for bank erosion (see Table 37). However, stream bank erosion was considered "poor" throughout the lower reaches of Hull Creek and associated tributaries. The majority of this area contains alluvial (water deposited soil) floodplains dominated by agriculture land use. Waterstrat (1994) estimated that over 90% of the stream banks were not fenced. However, over 80% of the stream banks were in stable condition, largely because farm animals were concentrated in only a few areas (Waterstrat 1994). Bank erosion along most of the upper reaches of Hull Creek and its tributaries rated "Fair".

**Table 37: Lower Grays River Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River (1)	46	75.4%	5	8.2%	9	14.8%	1	1.6%	61	100%
Seal Creek	4	57.1%	2	28.6%	1	14.3%	0	0.0%	7	100%
Malone Creek	3	50.0%	1	16.7%	2	33.3%	0	0.0%	6	100%
Impie Creek	6	75.0%	0	0.0%	2	25.0%	0	0.0%	8	100%
Nikka Creek	4	66.7%	1	16.7%	1	16.7%	0	0.0%	6	100%
Thadbar Creek	3	25.0%	1	8.3%	8	66.7%	0	0.0%	12	100%
Kessel Creek	4	66.7%	2	33.3%	0	0.0%	0	0.0%	6	100%
Hull Creek	45	70.3%	7	10.9%	12	18.8%	0	0.0%	64	100%
Honey Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Fall Creek	13	92.9%	1	7.1%	0	0.0%	0	0.0%	14	100%
Total	128	68.4%	20	10.7%	38	20.3%	1	0.5%	187	100%

TAG members noted that above State Highway 4 livestock and elk herds have created localized bank erosion problems. Stream surveyors (WCD 2001) also found localized erosion problems in the vicinity of the State Route 4 Bridge and along the county road in 1994. The lower 1,000-feet of Silver Creek rated "poor" with 80 percent of the stream banks exhibiting erosion. Stream bank erosion may be contributing sediment that has mostly filled a culvert on Silver Creek. Bank stability in Honey Creek rated "poor" with significant erosion throughout the three surveyed reaches. Livestock had access to approximately 40 percent of the area surveyed on Honey Creek (WCD 2001). Thirteen out of fourteen surveyed reaches along Fall Creek rated "good" for bank erosion.

#### *Substrate Fines*

Table 38 summarizes data collected by Wahkiakum Conservation District stream surveys for fine sediment conditions for each stream system in the lower Grays River watershed and its tributaries (see Appendix D for the protocols used to collect the data and apply the criteria). Over 76% of the surveyed stream segments within this area had "poor" fine sediment conditions. Many of the surveyed reaches within this area are tidally influenced and fine sediments naturally accumulate. As stream gradient increases in the

tributary streams gravel was observed but was noted as soft rock highly embedded with fines (WCD 2001). Sedimentary deposits dominate the surface geology in the area. The rock that is delivered to stream is weak and readily breaks down into sand and silt particles. Areas of flow convergence become increasingly important to maintain areas of relatively clean spawning gravels.

**Table 38: Lower Grays River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 1	0	0.0%	3	4.9%	58	95.1%	0	0.0%	61	100%
Seal Creek	0	0.0%	1	14.3%	6	85.7%	0	0.0%	7	100%
Malone Creek	1	16.7%	1	16.7%	4	66.7%	0	0.0%	6	100%
Impie Creek	0	0.0%	1	12.5%	7	87.5%	0	0.0%	8	100%
Nikka Creek	0	0.0%	0	0.0%	6	100.0%	0	0.0%	6	100%
Thadbar Creek	7	58.3%	3	25.0%	2	16.7%	0	0.0%	12	100%
Kessel Creek	2	33.3%	1	16.7%	3	50.0%	0	0.0%	6	100%
Hull Creek	3	4.7%	1	1.6%	60	93.8%	0	0.0%	64	100%
Honey Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Fall Creek	1	7.1%	3	21.4%	10	71.4%	0	0.0%	14	100%
Total	14	12.0%	14	11.3%	159	76.7%	0	0.0%	187	100.0%

Thadbar Creek was the only stream where a majority of the surveyed segments had “good” fine sediment conditions. Tag members also commented that Thadbar Creek had good spawning gravels in the upper reaches.

Tide gates on Impie Creek might be contributing to a buildup of silt in the lower reaches of Impie Creek (TAG). TAG members considered the quality of spawning gravels in Nikka Creek poor for spawning due to its softness.

Historically, gravel bar scalping was practiced in the lower Grays River (TAG). This practice maintained the river channel in a somewhat stable condition. While some TAG members believe that gravel bar scalping can provide benefits to salmon habitat and indicated their desire to keep some of these tools available, others considered this practice harmful to salmon and only a temporary solution to a watershed level problem.

The Conservation Commission’s Habitat Rating Standards (see Appendix B) use road densities as a surrogate for measuring fine sediment inputs to stream systems. Road densities greater than 3 miles/square mile are considered “poor” by this standard. There are approximately 443 miles of road in the entire Grays River watershed creating a road density of 7.32 miles/square mile (over twice the level considered “poor” by Conservation Commission standards). Only 13 percent of the roads were considered active (Waterstrat 1994). Two hundred and fifty-six (256) mass failures were noted on the 1986 Soil Survey Maps in the Grays River watershed. The largest numbers occurred on Lates silt loam, Bunker silt loam, Lytell silt loam, and Katula silt loam. All of these

failures occurred on slopes greater than 30%. The overall density of mass failures was 4.22 failures/square mile (Waterstrat 1994). This high rate of mass failures likely also contributes to the excessive fine sediment levels found by stream surveyors.

Of the approximately 39 miles of roads in the Hull Creek subbasin, only 11 percent are actively used. Soil Survey Maps (1986) noted 28 mass failures in the watershed. Most occurred on Bunker silt loam with 30-65 percent and 65-90 percent slopes. The overall density of mass failures was 2.30 failures/square mile (Waterstrat 1994).

Within the Malone Creek subbasin, there are approximately 10.4 miles of road with a density of 3.8 miles of road/square mile; approximately 80 percent of the roads are active. Five mass failures were noted on the 1986 Soil Survey Maps; these were primarily on Lytell silt loam with 30-65 percent slope. The overall density of mass failures is 1.83 failures/square mile (Waterstrat 1994).

#### *Riparian Conditions*

(Appendix A, Map A14)

Stream surveys determined that riparian conditions were generally “poor” along the lower Grays River watershed and its tributaries (see Table 39). Of the 61 segments surveyed along the lower Grays River, only six had “fair” and one had “good” riparian conditions. The other 55 reaches rated “poor”. Agriculture is the dominant land use along the mainstem Grays River and lower segments of all tributaries. The agricultural segments typically rated poor due to inadequate buffer width and/or the high percentage of deciduous species in the riparian corridor. The few stream segments along the lower Grays with either “fair” or “good” conditions were along reaches where forestry was the dominant land use (WCD 2001)(Map A14).

**Table 39: Lower Grays River Riparian Conditions (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 1	1	1.6%	5	8.2%	55	90.2%	0	0.0%	61	100%
Seal Creek	3	42.9%	1	14.3%	2	28.6%	1	14.3%	7	100%
Malone Creek	0	0.0%	1	16.7%	5	83.3%	0	0.0%	6	100%
Impie Creek	1	12.5%	1	12.5%	6	75.0%	0	0.0%	8	100%
Nikka Creek	0	0.0%	1	16.7%	5	83.3%	0	0.0%	6	100%
Thadbar Creek	1	8.3%	3	25.0%	7	58.3%	1	8.3%	12	100%
Kessel Creek	1	16.7%	1	16.7%	4	66.7%	0	0.0%	6	100%
Hull Creek	13	20.3%	14	21.9%	37	57.8%	0	0.0%	64	100%
Honey Creek	0	0.0%	1	33.3%	2	66.7%	0	0.0%	3	100%
Fall Creek	1	7.1%	9	64.3%	4	28.6%	0	0.0%	14	100%
Total	21	10.9%	37	22.9%	127	63.8%	2	2.3%	187	100%

Stream surveyors found the greatest percentage of reaches with “good” riparian conditions along Seal Creek (42.9%) and Hull Creek (20.3%).

Stream surveyors found that the agricultural segments on Impie and King Creeks had minimal buffers, but they did note that livestock were generally fenced away from the streams. The upper segments of all the tributary streams are predominantly forested. Riparian corridors along forested stream segments were dominated by coniferous species, but riparian conditions often rated “poor” because most trees were immature. The upper reaches of the Nikka Creek and Impie Creek watersheds were logged in the late 1970-80s (TAG).

The riparian zone along the Seal River had 200’ buffers and the content of conifer was generally 60% or greater (WCD 2001). Malone Creek riparian conditions rated “poor”, with mostly deciduous vegetation in buffers from 6 to 166 feet.

Riparian conditions in the lower segment of Hull Creek, downstream of Fall Creek, rated “poor” due to inadequate buffer widths and a lack of conifers. This area is predominantly agriculture land use with riparian widths ranging from ten to fifty feet. Livestock access to the stream was evident and streambank stability problems were noted throughout these surveyed segments (WCD 2001). TAG members noted that both cattle and a large population of elk had access to the lower reaches of Hull Creek. Land use along the lower segments of Honey Creek and Fall Creek was also predominantly agriculture, and riparian conditions were “poor”. The forested segments of Hull Creek received variable ratings. There is a good mix of conifer and deciduous species however age varies greatly.

Waterstrat (1994) estimated that approximately, 97 percent of the entire Grays River watershed was either privately owned industrial forest or state land; with 18 percent of the trees >50 years old, 73 percent 11-50 years, and 9 percent 0-10 years. Three percent of the subbasin is used for agricultural and/or residential purposes. No fences were visible along 88 percent of the stream banks in the agricultural lands. Based on counts, the average domestic farm animal density is estimated to be 0.23 animals/acre (Waterstrat 1994).

Approximately, 96 percent of the Hull subbasin is privately owned industrial forest or state lands; with 40 percent of the trees >50 years old, 20 percent 11-50 years, and 40 percent is 0-10 years. Four percent of the subbasin is used for agricultural and/or residential purposes. Observations, made along the stream in September 1993, found that over 90 percent of the riparian corridors were unfenced. Despite the lack of fencing, nearly 80 percent of stream banks were in good condition (Waterstrat 1994).

Malone Creek subbasin had approximately one percent of land area devoted to agriculture and/or residential uses. Because the animals are grouped in one location, >50 percent of the stream banks were in good condition even though approximately 97 percent of the stream banks in the agricultural portion appeared unfenced. The remaining

99 percent of this subbasin is privately owned industrial forest or state lands; with 60 percent of the trees is >50 years old, 25 percent 11-50 years, and 15 percent 0-10 years (Waterstrat 1994).

### *Large Woody Debris*

(Appendix A, Map A-15)

Table 40 lists data from Wahkiakum Conservation District stream surveys on the condition of large woody debris (LWD) in each stream system within the lower Grays River watershed area. Stream surveys found that LWD was almost non-existent in the lower reaches of the mainstem Grays River. LWD was either concentrated in jams at pilings or on river meanders, or that is transient in nature (WCD 2001).

Both LWD and riparian conditions rated “poor” in the Seal River. The upper segments of Seal River had some LWD, but this material was mostly in the form of logjams and small diameter deciduous species. The first 1,000 feet of Malone Creek rated “fair” for LWD, with most of the material being small diameter red alder, indicative of the riparian vegetation. Malone Creek watershed was logged in past 10 years (TAG). LWD in the upper segments of Malone Creek rated “good”. Most of the LWD observed in Malone Creek was smaller diameter material generally bound in logjams that collectively tends to function as one “key piece” of LWD.

Conditions were very similar for some of the smaller tributaries including Impie Creek, Nikka Creek, Thadbar Creek, and Kessel Creek. In the lower reaches LWD was either completely absent or widely scattered. In the transition areas from agriculture land use to forest, pieces of LWD increase and are mixed conifer and deciduous. However, the diameter of most LWD was typically less than 8 inches. The uppermost segment surveyed on Nikka Creek rated “fair” for LWD with a good mix of conifer and deciduous. Although the mainstem of Thadbar Creek rated “poor”, two of its tributaries in the upper watershed contained greater amounts of LWD. One tributary rated “good” with a mix of conifer and deciduous LWD. The other rated “fair” but was dominated by deciduous LWD. The surveyed portion of Kessel Creek rated “poor” for LWD. The forested segments (4-6) had a good mix of conifer and deciduous LWD; however, the diameters are small according to the rating criteria.

Large woody debris levels were “poor” in the Hull Creek watershed. Of the 80 stream segments surveyed, only three rated “fair” and one rated “good”. A good mix of conifer and deciduous material was noted although it is primarily of small diameter. Logjams are prevalent throughout the system.

**Table 40: Lower Grays River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 1	0	0.0%	1	1.6%	58	95.1%	2	3.3%	61	100%
Seal Creek	0	0.0%	0	0.0%	6	85.7%	1	14.3%	7	100%
Malone Creek	4	66.7%	2	33.3%	0	0.0%	0	0.0%	6	100%
Impie Creek	0	0.0%	0	0.0%	5	62.5%	3	37.5%	8	100%
Nikka Creek	0	0.0%	1	16.7%	4	66.7%	1	16.7%	6	100%
Thadbar Creek	1	8.3%	1	8.3%	9	75.0%	1	8.3%	12	100%
Kessel Creek	0	0.0%	0	0.0%	5	83.3%	1	16.7%	6	100%
Hull Creek	1	1.6%	3	4.7%	57	89.1%	3	4.7%	64	100%
Honey Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Fall Creek	0	0.0%	0	0.0%	13	92.9%	1	7.1%	14	100%
Total	6	7.7%	8	6.5%	160	75.0%	13	10.9%	187	100%

### *Percent Pool*

(Appendix A, map A16)

Table 41 provides data from Wahkiakum Conservation District stream surveys on the percentage of pool habitat in the surveyed stream segments in the lower Grays River watershed. Over 87% of the all the surveyed segments had a “poor” rating for the percentage of pool habitat (see Appendix B for Habitat Rating Standards). A major reason for this “poor” rating is that a number of the surveyed stream segments in the lower Grays River watershed area are tidally influenced, where the percentage of pools would be expected to fall below habitat standards.

TAG members considered the mainstem Grays River tidally influenced up to “Badgers Beach” located about 1 mile downstream of the State Route 4 Bridge. The lower 4,000 feet of Seal River is tidally influenced and pool frequency rated “poor”. The stream has been channelized throughout the tidally influenced area. As gradient increases in the upper reaches of Seal Creek, pool frequency improves to a “good” rating. Pool frequency throughout Malone Creek rated “poor”.

A tidegate limits tidal influence on Impie Creek. The lower segments are extremely low gradient, flow through alluvial soils, and are dominated by agriculture land use. Historic practices re-channeled the streams to increase usability and drainage. Pool frequency rated “poor” in these lower reaches. As stream gradient increases, the percentage of pool habitat tends to increase. Stream gradient in Impie Creek begins to increase 3,000 feet from the mouth and pool frequency improved from “poor” to “good”. At 6,000 upstream the gradient increases rapidly and the percentage of pool habitat tends to decline unless large woody debris is present.

**Table 41: Lower Grays River Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 1	1	1.6%	0	0.0%	60	98.4%	0	0.0%	61	100%
Seal Creek	2	28.6%	0	0.0%	3	42.9%	2	28.6%	7	100%
Malone Creek	0	0.0%	0	0.0%	5	83.3%	1	16.7%	6	100%
Impie Creek	2	25.0%	0	0.0%	6	75.0%	0	0.0%	8	100%
Nikka Creek	0	0.0%	0	0.0%	6	100.0%	0	0.0%	6	100%
Thadbar Creek	0	0.0%	4	33.3%	4	33.3%	4	33.3%	12	100%
Kessel Creek	0	0.0%	1	16.7%	5	83.3%	0	0.0%	6	100%
Hull Creek	0	0.0%	5	7.8%	58	90.6%	1	1.6%	64	100%
Honey Creek	1	33.3%	0	0.0%	2	66.7%	0	0.0%	3	100%
Fall Creek	0	0.0%	0	0.0%	14	100.0%	0	0.0%	14	100%
Total	6	3.2%	10	5.3%	163	87.2%	8	4.3%	187	100%

Percent pool rated “poor” in the six surveyed reaches of Nikka Creek. Stream surveys noted that the lower segments are extremely low gradient, flowing through alluvial soils, and dominated by agriculture land use. Historic practices re-channeled the streams to increase usability and drainage. A road crossing failure has impacted the mid- to upper-reaches of Nikka Creek, where the percentage of pools might be expected to improve. This failure served to scour the channel immediately below the structure and resulted in pool filling further downstream.

The percentage of pool habitat rated “poor” in 5 out of 6 surveyed reaches of Kessel Creek (see Table 41). Lower stream segments are extremely low gradient, flow through alluvial soils, and are dominated by agriculture land use. As stream gradient increased, the percentage of pool habitat also tended to increase. However, the transition between low and high gradient reaches occurs rapidly in this subwatershed.

The percentage of pool habitat in Thadbar Creek was highly variable. Areas of extremely low stream gradient were limited to the first 500 feet of Thadbar Creek. In the first five 1000-foot stream segments, Thadbar Creek is slightly entrenched yet has been allowed to meander through the alluvial deposits. Stream meanders provide for the presence of regularly spaced pools resulting in a “fair” percentage of pools. At 5,000 feet upstream, the percentage of pools declines due to a road crossing failure that scoured the channel immediately below the structure and resulted in pool filling further downstream. Pool information was not available for tributaries to Thadbar Creek.

The percentage of pool habitat in the Hull Creek watershed rated “poor”. The first seven reaches of Hull Creek are all tidally influenced.

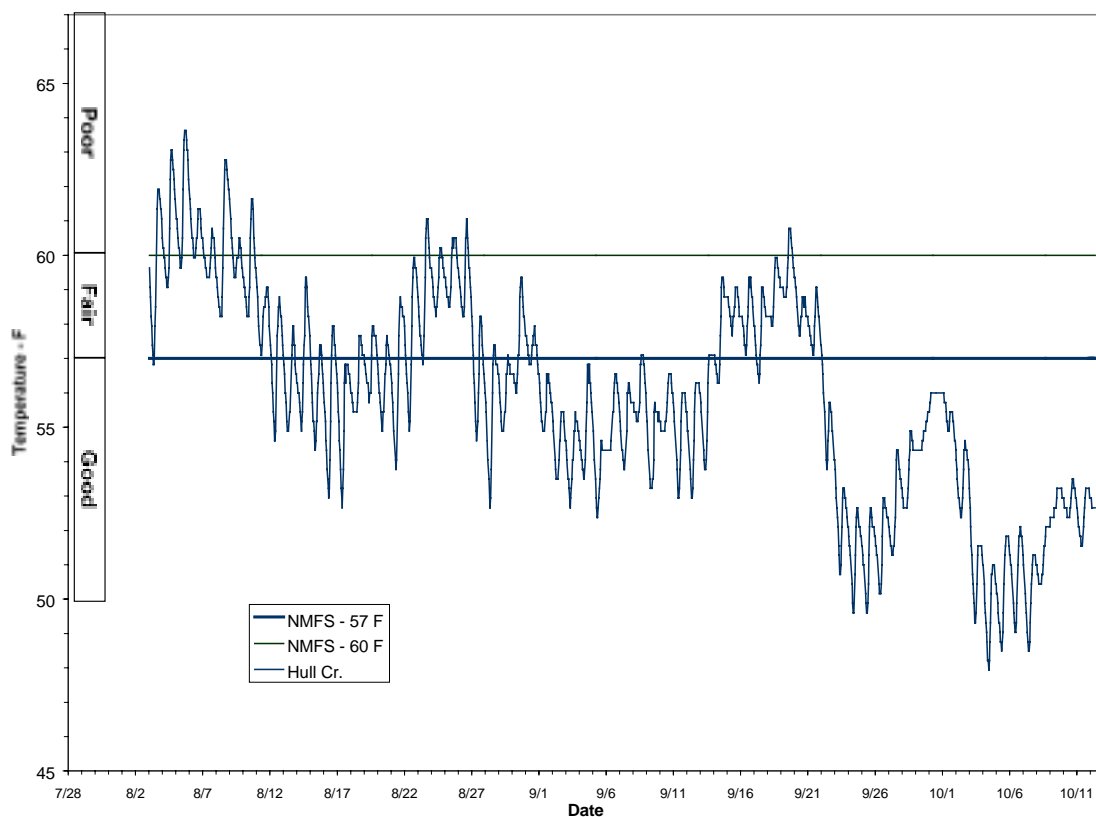
## Water Quality

(Appendix A Map A-10)

Historical data on water quality is very limited in the Grays River watershed. An Ambient Monitoring Site, 25B070-Grays River at RM 11.6 collected water quality data in 1997 and 1998. Sampling occurred between October and December of 1997 and during all of 1998. The highest temperatures recorded in 1998 were 15° C on 7/29/98 (DOE 2001). Fecal coliform exceeded the state limits in 8.3% of the samples taken in 1998 and none of the samples in 1997 (Hathhorn 2001: draft).

TAG members reported that Malone Creek has turbidity at high flows and indicated that numerous residents may have failing septic systems. TAG members noted that Impie Creek also had turbidity problems, but they were unsure of the cause.

**Figure 3: Hull Creek - Year 2000 Maximum Hourly Stream Temperature (WCD 2001)**



Beginning in 2000 the Wahkiakum Conservation District started to monitor the temperature in Hull Creek upstream of the SR4 Bridge. The District intends to monitor their temperature sites through 2004. Figure 3 illustrates the temperature data obtained from Hull Creek during the summer of 2000. Washington State Conservation Commission water temperature criteria have been applied to the figure as two horizontal

lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. Washington State water quality standards for Type A water are exceeded above 64.4 degrees Fahrenheit. Stream temperature increases to near 64° F (17.7° C) during the summer months when it can impact resident fish and rearing salmonids. Elevated temperatures are likely a combined effect of a rain-dominated system, low flows, and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Coho salmon may contend with elevated temperatures in the “fair” to “poor” range as they first enter the system in the fall.

#### *Water Quantity*

Substantial changes from historic conditions have occurred in the land cover of the Grays Bay Watershed Administrative Unit (WAU)(this WAU covers both the Grays Bay and Lower Grays watersheds – see Map A-17). Table 36 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 36 that over 67% of the land cover in the Grays Bay WAU is now in early seral stages, non-forest and other uses. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). High road densities increase channel lengths and direct overland flow directly to streams, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

As Map A-17 and Table 36 illustrate, the forest cover in the Grays Bay WAU is considered hydrologically immature and road densities exceed 3 miles/square mile, raising concerns for increased peak flows in streams in this area.

United State Geological Survey maintained a streamflow gaging station on the Grays River and on Hull Creek near the town of Grays River. The Grays River station (Station #14250000) was operated through a period from 1949 through 1951. The Hull Creek station (station #14251000) was operated during 1949 (USGS 1994).

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell et al. 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell et al. (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows for spawning and rearing salmon and steelhead. This information can be synthesized with streamflow gauging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on the Grays River at the State Route 4 Bridge and is presented in Table 42. Streamflow spot measurements are provided in Table 43. Caldwell et al. (1999) encouraged that the data be interpreted by biologists to "determine a minimum flow regime to protect and preserve instream flow for fish".

In comparing spot flow data from Table 43 with optimum toe-width flows in Table 42, stream flows on 10/1/97 were below optimum for salmon and steelhead spawning, but were more than adequate between 11/1/97 and 3/198. Stream flows on 6/1/98, 7/1/98, and 8/1/98 were all below optimum for all species for both spawning and rearing.

**Table 42: Toe Width Flows for the Grays River**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Reaing
Grays River @ State Route 4 Bridge	120.3	516.5	292.1	516.5	401.3	147.5	137.6

Caldwell et al, 1999

**Table 43: Streamflow Spot Measurement for the Grays River**

Stream Name	Measured Flows (in cfs)							
	Date							
	10/1/97	11/1/97	12/1/97	1/1/98	3/1/98	6/1/98	7/1/98	8/1/98
Grays River @ State Route 4 Bridge	206.6	1738.2	832.9	1183.3	1297.7	116.8	54.5	29.1

Caldwell et al, 1999

*Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams. Stream surveys in November of 1936 found 6,286 spawning or spawned out chum below the falls in the mainstem Grays (Bryant 1949). Spawning survey data show a sharp decline in chum escapement since 1960, and SASSI (WDF et al. 1993) considers Grays River chum depressed. Grays River coho were also considered depressed. Grays River fall chinook were considered healthy based on escapement trends; however, evidence suggests that few natural fall chinook juveniles are produced in the system (WDF et al. 1993). The winter steelhead stock status in the Grays River was also considered depressed (LCSCI 1998).

Middle Grays River Covered Bridge to Canyon:

(including King, Klints, and Fossil Creeks and Unnamed tributary, Crazy Johnson)

*Access*

(Appendix A, Map A2)

There were no artificial barriers that were identified in this part of the Grays River watershed. Summer low flows are the principal concern in this area affecting passage.

King Creek has low flow problems that may be tied to a diversion in the upper watershed (TAG). Historically, a pond was constructed in the headwaters of King Creek and Muddy Tributary to capture and store water from a spring for an unknown use. The dam was breached to return flow to King Creek when the source was abandoned. Beaver dammed King Creek at the pond site. The pond dam failed on the Muddy Creek tributary resulting in diversion of flow destined for King Creek.

Grays River breached the dike at Gorley Springs in the winter of 1999. The river has established a well-defined channel through most of its new alignment. However, a road in the mid section results in the river spreading across a field for several hundred yards. This condition could present a passage issues for juvenile fish until the river establishes its channel through this reach. The Gorley Springs area represents the transition between a confined stream channel with relatively high gradient and an unconfined stream channel

with low gradient. As such, it has always been subject to bedload deposition resulting in a braided channel with poor channel stability. Locals used to mine gravel from the area on a regular basis to maintain channel capacity (TAG). Prior to the dike breach in this area, bedload accumulation contributed to very low flows during the summer months. However, flows increase quickly with the onset of fall rains, and fall spawning stocks are able to access the upper reaches of the Grays River and its tributaries.

According to a 1949 report (Bryant), “In the canyon area approximately 13 miles above the mouth and 7-8 miles above tide water a difficult 8-foot cascade or falls was located and a second higher falls immediately above it.” TAG members noted that falls in the canyon were blasted in 1957 to improve fish passage.

#### *Floodplain Connectivity*

Several areas within this reach of the river have been managed to improve streambank stability. Historically, piles were driven into the streambed on the major bends to help deflect wood and protect banks during splash damming. Later, the more recognized approach of placing rock armor was used to stabilize streambanks. The effectiveness of these types of projects has alleviated landowner concerns but serves to further limit floodplain connectivity. A section of the Grays River at Gorley Springs was diked to protect farmland on the point bar. The Upper Grays River Flood Control District constructed rock groins on a bend of Grays River immediately upstream of Fossil Creek to reduce erosion concerns.

The lower mile of Klints Creek had been reconstructed to improve drainage in the past. During the winter of 1996, after significant flooding, the lower 1.5 miles of Klints Creek aggraded significantly. Although it has not been confirmed on the ground, it is believed that several mass wasting events (slides) significantly increased the bedload. The increased bedload served to reconnect Klints Creek to its floodplain and to recruit spawning gravel (WCD 2001).

Fossil Creek may also have experienced increased sediment delivery during the winter of 1996. A debris jam on Fossil Creek immediately upstream from the confluence with Grays River reduced the movement of sediment out of Fossil Creek, and Fossil Creek aggraded to within six inches of its floodplains for 3,000 feet upstream. Wahkiakum County efforts to reconnect Fossil Creek with the Grays River have triggered a headcut (erosion within the stream channel) that is working its way upstream. Local concerns for flooding has resulted in the construction of a temporary berm to contain flood flows. The Upper Grays River Flood Control District is attempting to obtain funds to assess watershed conditions and develop a restoration plan that will alleviate flooding concerns. WDFW TAG members confirmed that fisheries baseline data was available for Fossil Creek, so that opportunities exist to monitor fish response to natural events in this watershed.

### *Side Channel Availability*

Side channel availability was considered “poor” for this reach of the mainstem Grays River (TAG). However, side channels were observed in three segments, and surveyor notes indicated that these appeared to be good rearing habitat for juvenile fish.

King Creek and Fossil Creek are mostly single thread channels with little or no side channels observed during stream surveys. However, some side channel development was observed where LWD occurred in the mid-reaches of Klints Creek. The side channels observed in Fossil Creek were very short, less than 50 feet in length, and noted as transient.

### *Bank Erosion*

(Appendix A, Map A12)

Table 44 and Map A-12 provide data on bank stability from stream surveys conducted by the Wahkiakum Conservation District between 1994 and 1996. Active bank erosion was estimated for every 200-foot segment in 5 percent increments during the surveys. The estimated erosion was calculated by determining the length of the eroding area, both sides of the stream, compared to the 400 feet of total stream bank in the segment. The information collected during the stream surveys does not meet the Conservation Commission’s criteria for bank stability since erosion that occurred on outside bends, in areas where the channel was constricted, or where flow was deflected into a bank by local conditions was not noted in the surveys. Only those eroding areas in unexpected locations along straight areas and inside corners were noted. TAG members felt that this survey data is likely best used to identify areas where additional stream stability assessment is needed rather than an accurate picture of streambank stability in the watershed.

Bank erosion along a majority of the reaches surveyed in the mainstem Middle Grays River rated “good”. However, several banks have been armored and five rock groins were installed in the mainstem Grays River just upstream from Fossil Creek to protect the bank from erosion. While most of the mainstem in this area rated good for bank erosion, the Gorely Springs area is a natural depositional area and substantial bedload accumulation results in highly unstable channel conditions. During the winter of 1999, the dike at Gorely Springs, just upstream from the West Fork, failed and the river changed course. Since 1999, the river has been highly unstable as it moves across the existing floodplain, slowly developing a channel capable of moving sediment loads under the existing conditions.

Bank erosion within the lower two thousand feet of King Creek rated “poor”. This area is predominantly agriculture land use and past attempts to armor the stream banks are evident throughout this reach. The upper reaches of King Creek are predominantly forested and bank stability rated “fair” with the exception of a tributary that rated “poor”. This tributary appears to have experienced a debris torrent that scoured the channel and is likely responsible for some of the problems noted in downstream reaches.

Klints Creek bank erosion rated “fair” overall with a few segments exhibiting erosion along 60 percent of the streambanks. Shallow slides were observed on regular intervals along the north streambank that may contribute to stability concerns. These slides appear to correspond closely with the drainage culverts along State Route 4 (WCD 2001).

**Table 44: Middle Grays River Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River (2)	20	90.9%	0	0.0%	2	9.1%	0	0.0%	22	100%
King Creek	1	11.1%	5	55.6%	3	33.3%	0	0.0%	9	100%
Klints Creek	5	31.3%	9	56.3%	2	12.5%	0	0.0%	16	100%
Fossil Creek	5	35.7%	0	0.0%	9	64.3%	0	0.0%	14	100%
Unnamed Trib	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	100%
Total	32	51.6%	14	22.6%	16	25.8%	0	0.0%	62	100%

The lower reaches of Fossil Creek rated “poor” for bank stability. These reaches were identified as highly entrenched according to stream surveyors. This situation has changed since the surveys were conducted as the stream has aggraded due to mass wasting events in the upper watershed (WCD 2001). The upper reaches of Fossil Creek are highly variable with both “poor” and “good” erosion ratings.

#### *Substrate Fines*

(Appendix A, Map A13)

TAG members indicated that excessive bedload deposition and instability were the major substrate problems in this reach of the mainstem Grays, not substrate fines. However, stream surveys indicated that a majority of the segments observed on this reach of the Grays River also rate as “poor” for sediment fines (see Table 45). The lower segments of the tributary streams are extremely low gradient channels whose substrate is dominated by fine sediment. As stream gradient increases in the tributary streams gravel was observed but was noted as soft rock highly embedded with fines (WCD 2001). The surface geology in the area is dominated by near shore sedimentary deposits. The rock that is delivered to most of these streams is weak and readily breaks down into sand and silt particles. Areas of flow convergence become increasingly important to maintain areas of relatively clean spawning gravel. The geology of King Creek is an exception in this reach of the Grays River, since King Creek’s rock substrate is dominated by basalt believed to originate from the Elk Mountain outcrop.

Table 45 shows that the percentage of fine sediments in a majority of the surveyed stream reaches in King, Klints, and Fossil Creeks fell in the “good” category by Washington Conservation Commission standards (see Appendix B for habitat rating standards).

TAG members reported that mass wasting, poor quality spawning gravel, and numerous logjams (one huge sediment dam was 10’ high x 145’ long) all affected sediment

conditions in Fossil Creek. TAG members noted that Crazy Johnson Creek had harder rock available for spawning with some fines on lower end. While this creek is often considered good chum spawning habitat, WDFW TAG members indicated that the most productive chum spawning habitat likely occurs on the floodplain of the Grays River at the confluence of Crazy Johnson Creek, not necessarily in Crazy Johnson Creek itself.

**Table 45: Middle Grays River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 2	6	27.3%	3	13.6%	13	59.1%	0	0.0%	22	100%
King Creek	5	55.6%	2	22.2%	2	22.2%	0	0.0%	9	100%
Klints Creek	10	62.5%	2	12.5%	4	25.0%	0	0.0%	16	100%
Fossil Creek	7	50.0%	1	7.1%	6	42.9%	0	0.0%	14	100%
Unnamed Trib	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	28	39.1%	8	11.1%	26	49.8%	0	0.0%	62	100.0%

### *Riparian Conditions*

(Appendix A Map A-14)

Table 46 and Map A-14 provide data from Wahkiakum Conservation District stream surveys (see Appendix D for description of survey protocols). Stream surveys determined that 54.8% of the reaches in this area had “poor” riparian conditions and 43.7% of the reaches had “fair” conditions. Twenty out of 22 reaches surveyed along the mainstem Grays had “poor” riparian conditions. Agriculture is the dominant land use along the mainstem Grays River, as well as the lower segments of all tributaries; although the west side of the Grays River upstream of State Route 4 is forested. The segments in agriculture land use typically rated “poor” due to inadequate buffer width or the dominance of deciduous species. Livestock had access to streams and riparian zones in many of the agricultural areas along King, Klints, and Fossil Creeks, degrading riparian habitat. TAG members believed that some of the livestock access issues had been resolved along King Creek. They also noted that fences existed along most of Fossil Creek, but that many fences were not managed to exclude livestock access.

**Table 46: Middle Grays River Riparian Conditions (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 2	0	0.0%	2	9.1%	20	90.9%	0	0.0%	22	100%
King Creek	0	0.0%	4	44.4%	5	55.6%	0	0.0%	9	100%
Klints Creek	0	0.0%	7	43.8%	9	56.3%	0	0.0%	16	100%
Fossil Creek	1	7.1%	3	21.4%	10	71.4%	0	0.0%	14	100%
Unnamed Trib	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1	100%
Total	1	1.4%	17	43.7%	44	54.8%	0	0.0%	62	100.0%

The upper segments of all the tributary streams are predominantly forest. These segments are dominated by coniferous species but generally rated “poor” or “fair” because riparian trees in the area are mostly immature. The majority of surveyed reaches along Klints Creek had “poor” riparian conditions. Riparian conditions rated “poor” along Crazy Johnson Creek, since riparian vegetation consists mainly of deciduous brush.

*Large Woody Debris (LWD)*  
(Appendix A Map A-15)

Table 47 and Map A-15 provide data on large woody debris in the middle Grays River and its tributaries. Large woody debris is almost nonexistent in this reach of the mainstem Grays River and in most of the tributaries. The tributary streams, King Creek, Klints Creek, and Fossil Creek, all rated “poor” for LWD. Stream surveyors noted a good mix of conifer and deciduous LWD along King Creek; however, a majority of the woody material was of small diameter. Although the quantity of LWD is lacking, the middle segments (6-14) of Klints Creek contain several large diameter conifer logs and debris jams. Much of this material was delivered to the stream through mass wasting events. Stream surveyors noted that this reach of stream was highly complex and appeared that it would provide excellent fish habitat. According to stream surveyors (WCD 2001), LWD is creating complex habitat and building a “flat” in segments 6-14 of Klints Creek (WCD 2001). LWD is often removed from stream systems in this area, since it is seen as an impediment to drainage and bank stability (TAG).

A large debris jam was noted in Fossil Creek at its confluence with the Grays River during stream surveys. This debris jam aided in the aggradation of the Fossil Creek stream channel. In general the LWD in Fossil Creek observed during stream surveys was primarily small diameter material; however, a good mix of conifer and deciduous LWD is present. Crazy Johnson Creek LWD rated “poor” (TAG).

**Table 47: Middle Grays River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 2	0	0.0%	0	0.0%	16	72.7%	6	27.3%	22	100%
King Creek	0	0.0%	0	0.0%	9	100.0%	0	0.0%	9	100%
Klints Creek	0	0.0%	0	0.0%	16	100.0%	0	0.0%	16	100%
Fossil Creek	0	0.0%	0	0.0%	14	100.0%	0	0.0%	14	100%
Unnamed Trib	1	100%	0	0.0%	0	0.0%	0	0.0%	1	100%
Total	1	20.0%	0	0.0%	55	74.5%	6	5.5%	62	100.0%

### *Pool Frequency*

(Appendix A Map A-16)

Table 48 and Map A-16 provide data from Wahkiakum Conservation District stream surveys on the percentage pool habitat that occurs in the middle reaches of the Grays River and its tributaries. The majority of all surveyed stream segments in this area rated “poor” for percent pool (for channels >15m wide, <35% pools by surface area is considered “poor” – see Appendix B). Stream surveys found that all stream segments in the mainstem Grays through this area had a “poor” percentage of pool habitats.

Percent pool habitat is “poor” in the lower three thousand feet of King Creek (see Table 48). These lower segments are extremely low gradient, flow through alluvial soils, and are dominated by agriculture land use. Historic practices re-channelled the streams to increase usability and drainage. Stream surveys determined that as stream gradient increases the percentage of pool habitat tends to improve to “fair”.

**Table 48: Middle Grays River Percent Pool (# of reaches and % of total)**

<b>LFA Stream</b>	<b>Good</b>		<b>Fair</b>		<b>Poor</b>		<b>No Data</b>		<b>Total</b>	
	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>	<b>#</b>	<b>%</b>
Grays River 2	0	0.0%	0	0.0%	22	100.0%	0	0.0%	22	100%
King Creek	0	0.0%	4	44.4%	3	33.3%	2	22.2%	9	100%
Klints Creek	3	18.8%	3	18.8%	9	56.3%	1	6.3%	16	100%
Fossil Creek	0	0.0%	1	7.1%	13	92.9%	0	0.0%	14	100%
Unnamed Trib	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	3	4.8%	8	12.9%	48	77.4%	3	5.7%	62	100%

Stream surveys determined that the percent of pool habitats was “poor” in the lower six thousand feet of Klints Creek. The lower segments are extremely low gradient, they flow through alluvial soils, and are dominated by agriculture land use. Historic practices re-channelled the stream to support agricultural activities and increase drainage. As stream gradients increase on Klints Creek, the percentage of pool habitat tends to increase, and surveys found that some of the upper reaches rated “good” for percent pools. Analysis of stream surveys determined that stream segments that rated “fair” and/or “good” for percent pool correspond closely with segments where LWD and logjams were observed (WCD 2001).

All but one of the 14 stream reaches surveyed in Fossil Creek had a “poor percentage of pool habitats. Although overall large woody debris ratings were “poor” for Fossil Creek, the one stream segment that rated “fair” for pool frequency corresponds with the segments where LWD and logjams were observed.

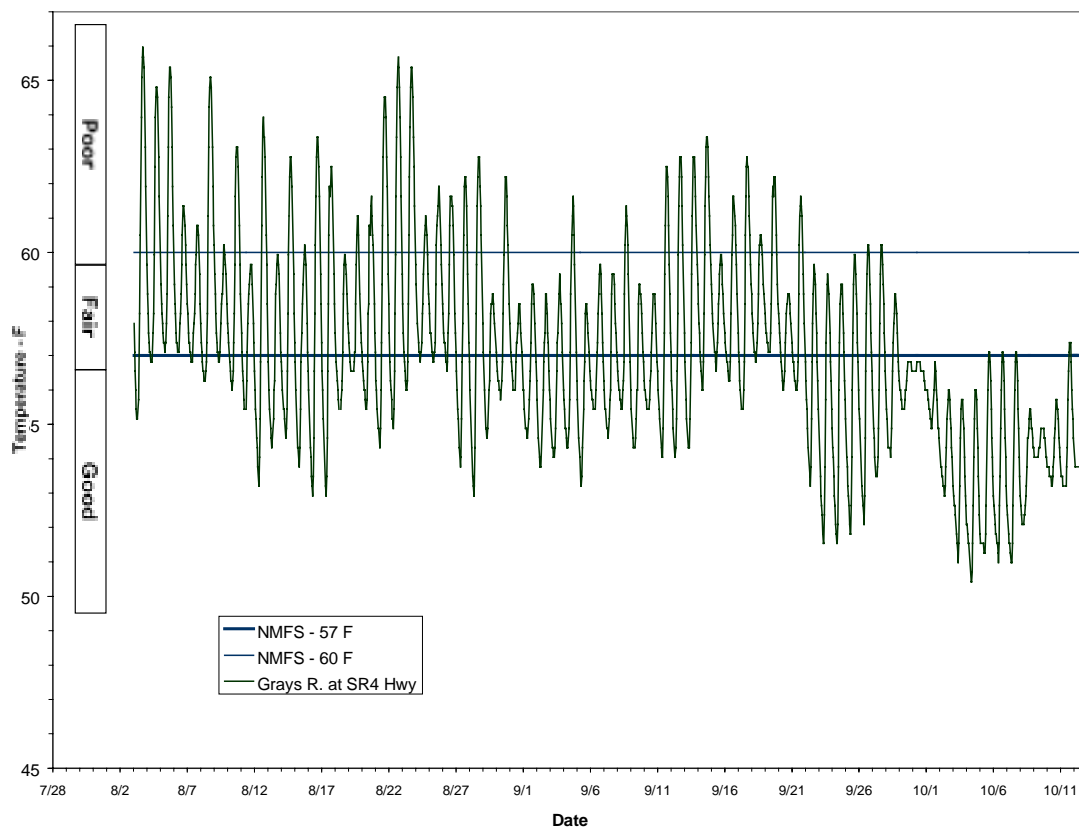
### *Water Quality*

Washington State Department of Ecology (2001) maintained an ambient monitoring site (Station #25B070) on the Grays River at the State Route 4 Bridge (RM 11.6). The majority of the data available was collected during a period from 1972 through 1977. Some of the specific parameters that DOE monitored include: flow, temperature, specific conductivity, dissolved oxygen, nitrogen, phosphorous, pH, and suspended solids (WDOE 2000). The lower Grays River was placed on the states water quality concern list (305b list) based on stream temperature observed at this site. However, the data was not sufficient to warrant listing on the state list of water quality impaired waterbodies (303d list).

Beginning in 2000 the Wahkiakum Conservation District began monitoring temperature in the Grays River at SR4 Bridge. The District intends to monitor this temperature site through 2004. Figure 4 illustrates the temperature data obtained from Grays River near State Route 4 during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. An additional important line could be plotted to highlight the state water quality standard for Type A water of 64.4 degrees Fahrenheit. Stream temperature rises during the summer months when it becomes a concern for resident fish and rearing salmonids. Figure 4 illustrates that stream temperatures are elevated above the Conservation Commission's Habitat Rating Standards well into September. Elevated summer temperatures are likely the combined effect of a rain-dominated system, low flows, and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets, and stream temperatures reach "good" conditions during the majority of salmonid spawning periods. Coho salmon may contend with temperatures in the "fair" to "poor" temperature range as they first enter the system.

Data is lacking for water quality on the tributary streams to the Grays in this reach. Turbidity levels appear elevated in the lower reaches of Klints Creek (TAG). TAG members noted that a tributary to Klints Creek was the most likely source of this turbidity. At its headwaters, a spring that historically flowed into King Creek had been diverted into a pond for a water source. It appears that beaver blocked the outlet to the creek and the pond breached into an ephemeral draw. The increased flow caused "massive" erosion in this unnamed tributary (a stream surveyor named the draw "Muddy Trib). This tributary to King Creek runs turbid even in the driest of summer months (TAG).

**Figure 4: Grays River near St. Rt. 4 - Year 2000 Hourly Maximum Stream Temperature**



### *Water Quantity*

Data on flow conditions within this reach of the Grays River and its tributaries is lacking. Substantial changes from historic conditions have likely occurred in the land cover of this reach of the Grays River and its tributaries. A majority of the land cover for upstream Watershed Administrative Units (WAUs) is now in early seral stages, non-forest, and other land covers. Subsequently, receiving waters downstream of these areas likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Upstream WAUs also have road densities that exceed 3.0 miles of road/square mile. These high road densities increase channel lengths; potentially contributing to increased peak flows and potentially reduced summer flows (Booth 2000; Furniss et al. 1991). Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically

immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

The Grays River supplies domestic water to approximately 205 families/businesses. The water system is a shallow well located on the floodplain immediately downstream of the State Route 4 Bridge.

TAG members noted that King Creek has low flow problems. This is due to a reported landslide in the upper reach that diverted the creek.

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

Stream surveys in November of 1936 found 6,286 spawning or spawned out chum below the falls in the mainstem Grays (Bryant 1949). Spawning survey data show a sharp decline in chum escapement since 1960, and SASSI (WDF et al. 1993) considers Grays River chum depressed. Grays River coho were also considered depressed. Grays River fall chinook were considered healthy based on escapement trends; however, evidence suggests that few natural fall chinook juveniles are produced in the system (WDF et al. 1993). The winter steelhead stock status in the Grays River was also considered depressed (LCSCI 1998).

### West Fork Grays River

(Beaver, Shannon, and Sneigiler Creeks and an unnamed tributary)

### *Access*

(Appendix A, Map A2)

The Grays River Hatchery, RM 1.2 on the West Fork maintains a weir for temporary fish collection. WDFW TAG members indicated the weir is usually taken out by high flows. Beaver Creek has a 100-foot falls 0.2 miles upstream from its mouth. Shannon Creek has a large amount of bedload accumulating in the lower reaches, and TAG members indicated that its flow goes subsurface during summer months.

### *Floodplain Connectivity*

Data was generally lacking on floodplain connectivity in this portion of the watershed. Many of the streams flow through steep canyons, with little opportunity floodplain development. TAG members indicated that the West Fork Grays River is highly entrenched.

### *Side Channel Availability*

Side channels were observed in most of the segments surveyed in the West Fork Grays River. These side channels are highly variable. Most of them are generally short in length (30-150 feet in length) and predominantly overflow channels that are transient in nature (WCD 2001). TAG members noted that downstream of the West Fork Hatchery side channels provided some high quality habitat.

### *Bank Erosion*

(Appendix A, Map A12)

Table 49 and Map A-12 provide data on bank erosion collected during Wahkiakum Conservation District stream surveys. Stream surveys noted few problems with bank erosion in the West Fork Grays River and their data places bank erosion in the “good” category for the West Fork Grays and Shannon Creek (see Appendix D for a description of how bank erosion was defined). However, TAG members indicated that streambank stability should be rated “poor” throughout the West Fork Grays River watershed due to the tremendous amount of mass wasting that occurs in the system. TAG members felt that this streambank erosion data is likely best used to identify areas where additional stream stability assessment is needed rather than an accurate picture of overall streambank stability in the watershed. Debris flows from these mass wasting events occur frequently. The West Fork Grays becomes confined above the hatchery and shallow rapid slides often occur (WCD 2001). TAG members indicated that the confined nature of the West Fork and the sediment load from mass wasting in the upper watershed keeps the river in a constant state of flux. The lower West Fork Grays channel has shifted its several times over the years (TAG).

The one surveyed reach of Beaver Creek rated “good” for bank erosion.

**Table 49: West Fork Grays River Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
West Fork Grays	23	95.8%	1	4.2%	0	0.0%	0	0.0%	24	100%
Shannon Creek	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	100%
Total	24	96.0%	1	4.0%	0	0.0%	0	0.0%	25	100%

### *Substrate Fines*

(Appendix A Map A-13)

Table 50 and Map A-13 provide data on substrate fines condition from Wahkiakum Conservation stream surveys (see Appendix D for an explanation of how conditions were rated). Of the 25 surveyed reaches, 22 reaches rated “poor” for substrate fines. The stream surveys noted sandy substrates in many of the reaches. High road densities (4.42 miles of road /square mile) and numerous mass slope failures (4.29 mass failures/square

mile) contribute to the excessive amounts of fine sediments (Waterstrat 1994). TAG members noted that the watershed has experienced extensive logging operations. Most slope failures occur on Bunker silt loam with 30-65 percent and 65-90 percent slopes and Lates silt loam with 30-65 percent and 65-90 percent slopes (Waterstrat 1994). An annual precipitation rate of up to 110 inches adds to the potential slope instability in the watershed.

**Table 50: West Fork Grays River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
West Fork Grays River	1	4.2%	2	8.3%	21	87.5%	0	0.0%	24	100%
Shannon Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	1	2.1%	2	4.2%	22	93.8%	0	0.0%	25	100.0%

### *Riparian Conditions*

(Appendix A Map A-14)

Table 51 and Map A-14 provide data on riparian conditions in the surveyed reaches of West Fork Grays watershed. Of the 25 surveyed reaches, all but three had “poor” riparian conditions. The three reaches with “fair” riparian conditions occurred in the upper West Fork Grays and upper Shannon Creek (WCD 2001). All but one surveyed reach had 200-foot or greater riparian buffer width. The lower 3 miles of the West Fork’s riparian corridor is dominated by deciduous species (WCD 2001). The upper segments exhibit a good mix of conifer and deciduous species but are generally immature. TAG members indicated that extensive logging was occurring in this watershed.

Ninety-nine percent of the West Fork Grays watershed is privately owned industrial forest or state lands. Forest vegetative cover has been characterized as; 24 percent is 50+ years old, 66 percent is 11-50 years old, and 10 percent is 0-10 years old (Waterstrat 1994).

**Table 51: West Fork Grays River Riparian Conditions (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
West Fork Grays River	0	0.0%	3	12.5%	21	87.5%	0	0.0%	24	100%
Shannon Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	0	0.0%	3	6.3%	22	93.8%	0	0.0%	25	100%

### *Large Woody Debris (LWD)*

(Appendix A Map A-15)

Table 52 and Map A-15 provide data from Wahkiakum Conservation District stream surveys on large woody debris (LWD) conditions. All surveyed reaches of the West Fork Grays watershed rated “poor” for LWD. Most of the LWD observed in the West Fork Grays is concentrated in debris jams. Several debris jams, one massive, was noted 5,000 feet upstream from the confluence with the Grays River. Large quantities of LWD have been deposited on the floodplains immediately downstream of the West Fork Hatchery. TAG members indicated that this watershed has experienced substantial logging activity over the years, and that logging debris contributed substantially to these debris jams. Bryant (1949) indicated that early surveys found the West Fork blocked to fish passage at RM 3.2 due to large accumulations of logging debris. TAG members also noted that a tremendous amount of mass wasting occurs in the watershed, resulting in debris flows that can lead to additional logjams. A majority of the LWD observed in this subwatershed was deciduous (WCD 2001).

**Table 52: West Fork Grays River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
West Fork Grays River	0	0.0%	0	0.0%	24	100.0%	0	0.0%	24	100%
Shannon Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	0	0.0%	0	0.0%	25	100.0%	0	0.0%	25	100%

### *Percent Pool*

(Appendix A Map A-16)

Table 53 and Map A-16 provide data from Wahkiakum Conservation District stream surveys on the percentage of pool habitat in the West Fork Grays River watershed. The percentage of pool habitat for all surveyed reaches in this watershed rated “poor”. The few pools that were observed were channel forced or associated with logjams (WCD 2001).

**Table 53: West Fork Grays River Percent Pool (# of reaches and % of total)**

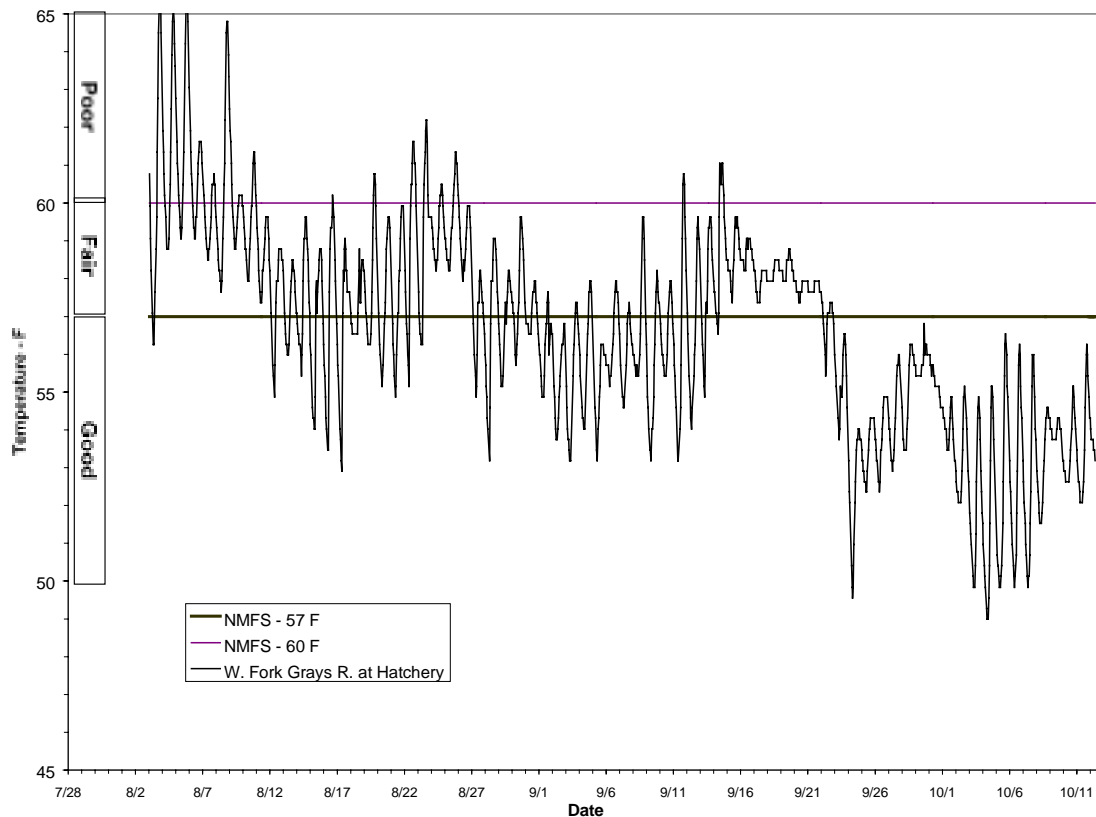
LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
West Fork Grays	0	0.0%	0	0.0%	24	100.0%	0	0.0%	24	100%
Shannon Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Total	0	0.0%	0	0.0%	25	100.0%	0	0.0%	25	100%

### Water Quality

The West Fork Grays River is listed for temperature on the state's list of impaired water bodies (WDOE 1998a). WDFW temperature data from the West Fork Grays River Salmon Hatchery (RM 1.2) show numerous excursions beyond Washington State's water temperature criterion (WSDOE 1998a)(see Map A-10). Temperature data is available at the West Fork Hatchery from 1985 through the present. USGS stream gauging station data from this location is available from 1949-69. TAG members also indicated that the West Fork Grays often has high turbidity levels.

Beginning in 2000 the Wahkiakum Conservation District started to monitor the temperature in the West Fork Grays River at the hatchery. This monitoring will be conducted annually through 2004 (WCD 2000). Figure 5 illustrates the temperature data obtained from the West Fork Grays River during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs (see Appendix B for rating standards). State water quality standard for Type A water is 64.4 degrees Fahrenheit.

**Figure 5: West Fork Grays River - Year 2000 Hourly Maximum Stream Temperature**



Stream water temperatures increase during the summer months when it can negatively impact resident fish and rearing salmonids. Elevated summer water temperatures are likely the combined effect of a rain-dominated system, low flows, and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods.

#### *Water Quantity*

United State Geological Survey maintained a streamflow gauging station on the West Fork Grays River (station #14250500). This station was operated from 1949 to 1969 (Williams 1985).

Substantial changes from historic conditions have occurred in the land cover of the Main Fork Watershed Administrative Unit (WAU)(same as the West Fork watershed). Table 54 provides land cover data that was originally derived from 1988 Landsat Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 54 that 65% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities of greater than 4.5 miles of road/square mile also increase channel lengths; potentially contributing to increased peak flows and potentially reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. As Map A-17 illustrates, the forest cover in the Main Fork WAU is considered hydrologically immature and road densities exceed 3 miles/square mile, raising concerns for increased peak flows in streams in this area.

**Table 54: Forest Seral Stage/ Land Cover in the Main Fork WAU (West Fork Grays) (Acres and Percent of Total)**

<i>WAU Name</i>	<i>Seral Stage</i>	<b>Late-Seral</b>	<b>Mid-Seral</b>	<b>Early-Seral</b>	<b>Water</b>	<b>Non-Forest</b>	<b>Other</b>	<b>Total</b>
<b>Main Fork</b>	<b>Acres</b>	347	3,275	742	0	12	5963	16,765
	<b>Percent</b>	3.3	31.7	7.2	0	0.1	57.7	100.0

Waterstrat (1994) analyzed land cover and land uses within many of the watersheds in Wahkiakum County. They found that over 99% of the West Fork watershed is either privately owned industrial forest or state land. According to Waterstrat (1994), data collected in 1992 by DNR shows that approximately 24% of the timber in the watershed is >51 year-old; 66% is between 11 and 50 year-old; and the remaining 10% is <10 year-old. Road densities were measured at 4.42 miles of road/square mile. Annual precipitation is approximately 110 inches (Waterstrat 1994).

Data is lacking on low flow conditions in the West Fork and its tributaries.

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

Stream surveys in November of 1936 found 6,286 spawning or spawned out chum below the falls in the mainstem Grays (Bryant 1949). Spawning survey data show a sharp decline in chum escapement since 1960, and SASSI (WDF et al. 1993) considers Grays River chum depressed. Grays River coho were also considered depressed. Grays River fall chinook were considered healthy based on escapement trends; however, evidence suggests that few natural fall chinook juveniles are produced in the system (WDF et al. 1993). The winter steelhead stock status in the Grays River was also considered depressed (LCSCI 1998).

### South Fork Grays River:

(including Blaney Creek and its tributaries)

### *Access*

(Appendix A, Map A-2)

There are no known man-made passage barriers within the surveyed reaches of the South Fork Grays River and its tributaries. However, there are numerous natural barriers that may impede fish passage. WDFW TAG members thought that a falls on the South Fork Grays at RM 3 might impede fish passage barrier at certain flows. Conservation District stream surveys noted numerous small falls and cascades that were considered passable at higher flows. Blaney Creek has a 30-foot falls located one mile from its confluence with the South Fork. The first tributary to Blaney Creek has an 8-foot falls, 300 feet its mouth plus many old blown out log culverts. All the falls and old culverts need assessment with standard protocols to evaluate fish passage and prioritize culvert removal.

### *Floodplain Connectivity*

Information was not available to assess floodplain connectivity in the South Fork watershed. A 1949 report (Bryant) indicated that an abandoned splash dam 40 feet high

is located 260 yards above the mouth of the South Fork Grays. Splash dams operated in the mainstem Grays River (RM 22.7), approximately 5 miles upstream of the confluence with the South Fork Grays and in the South Fork Grays (Bryant 1949). In many areas across the Pacific Northwest, splash dams left a legacy of eroded streambeds and incised channels that were disconnected from their floodplains (Sedell et al. 1991).

#### *Side Channel Availability*

Side channels were observed in the middle segments of the South Fork Grays River during Wahkiakum Conservation District stream surveys. Mid-channel bars are forming probably in response to heavy bedload deposition and resulting in some side channel development (WCD 2001).

#### *Bank Erosion*

(Appendix A Map A-12)

Table 55 and Map A-12 provide data from Wahkiakum Conservation District stream surveys on actively eroding streambanks in the South Fork Grays River watershed. While stream surveys found a low percentage of actively eroding streambanks, TAG members considered bank stability a major problem in the South Fork. TAG members felt that the streambank erosion survey data is likely best used to identify areas where additional stream stability assessment is needed rather than an accurate picture of overall streambank stability in the watershed. Industry representatives (Willamette Industries 1997) indicated that a large area upstream of where the stream survey ended (12,000 feet above confluence with Grays River) was highly unstable and the major source of turbidity in the South Fork. High turbidity was observed following minor rain events as well as during winter runoff during stream surveys (WCD 2001).

**Table 55: South Fork Grays River Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
South Fork Grays	11	91.7%	0	0.0%	1	8.3%	0	0.0%	12	100%
Blanney Creek	4	66.7%	2	33.3%	0	0.0%	0	0.0%	6	100%
Total	15	83.3%	2	11.1%	1	5.6%	0	0.0%	18	100%

Stream surveys determined that the lower 3,000 feet of Blanney Creek is aggrading and the channel is shifting laterally (WCD 2001). TAG members indicated that substantial mass wasting events have occurred in the upper reaches, due largely to the unstable geology and steep topography.

### *Substrate Fines*

(Appendix A Map A-13)

Table 56 and Map A-13 provide data from Wahkiakum Conservation district stream surveys on substrate fines in the South Fork Grays River watershed. Substrate fines in the lower three reaches (3,000 feet) of the South Fork Grays rated “poor”. These lower reaches appear to be aggrading as a result of increased bedload (WCD 2001). TAG members noted that the South Fork carries a heavy sediment load, and that sediment conditions were generally very unstable. There are some good quality spawning gravels available in the system and fines are flushed from the gravels; however, the instability likely reduces spawning success. Where a stream gradient is >4%, generally considered transport reaches, substrate fines were not generally a problem.

**Table 56: South Fork Grays River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
South Fork Grays River	9	75.0%	0	0.0%	3	25.0%	0	0.0%	12	100%
Blaney Creek	0	0.0%	1	16.7%	5	83.3%	0	0.0%	6	100%
Total	9	37.5%	1	8.3%	8	54.2%	0	0.0%	18	100%

Blaney Creek rated “poor” overall for substrate fines due to a significant amount of sand size material. TAG members indicated that opportunities exist for road improvements in this area. Many of the roads are built on old railroad grades. They also described the upper watershed as very unstable.

### *Riparian Conditions*

(Appendix A Map A-13)

Table 57 and Map A-13 provide data from Wahkiakum Conservation district stream surveys on riparian conditions in the South Fork Grays River watershed. Only one out of 18 surveyed reaches met “good” riparian standards. This “good” reach was in the upper South Fork Grays River. Stream surveys determined that riparian conditions in the lower mile of the South Fork Grays River and in Blaney Creek were “poor”. This area is dominated by deciduous species. Riparian conditions improve in the mainstem upper reaches. The upper reaches contain a good mix of conifer and deciduous species, but the vegetation is generally immature (WCD 2001).

**Table 57: South Fork Grays River Riparian Conditions (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
South Fork Grays River	1	8.3%	8	66.7%	3	25.0%	0	0.0%	12	100%
Blaney Creek	0	0.0%	2	33.3%	4	66.7%	0	0.0%	6	100%
Total	1	4.2%	10	50.0%	7	45.8%	0	0.0%	18	100%

*Large Woody Debris (LWD)*

(Appendix A Map A-15)

Very little large woody debris was observed in the South Fork Grays River and its tributaries during stream surveys. Table 58 shows that all surveyed reaches in the South Fork and in Blaney Creek rated “poor” for LWD. TAG members confirmed that even large LWD does not persist in the South Fork Grays since much of it is a high-gradient, high-energy system, and LWD is either transported out of the system or deposited on the floodplains during high flows.

**Table 58: South Fork Grays River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
South Fork Grays River	0	0.0%	0	0.0%	10	83.3%	2	16.7%	12	100%
Blaney Creek	0	0.0%	0	0.0%	6	100.0%	0	0.0%	6	100%
Total	0	0.0%	0	0.0%	16	91.7%	2	8.3%	18	100%

*Percent Pool*

(Appendix A Map A-16)

Stream surveys found that pool habitat is extremely limited in the South Fork Grays watershed. Wahkiakum Conservation District stream surveys (see Table 59) found no reaches where the percentage of pool habitat met even the “fair” rating. The lack of pool habitat is likely related to the lack of LWD that helps form pools, and the large sediment load carried by the river that fills in existing pool habitat. TAG members indicated that the percentage of pool habitat might improve in the upper watershed.

**Table 59: South Fork Grays River Percent Pool (# of reaches and % of total)**

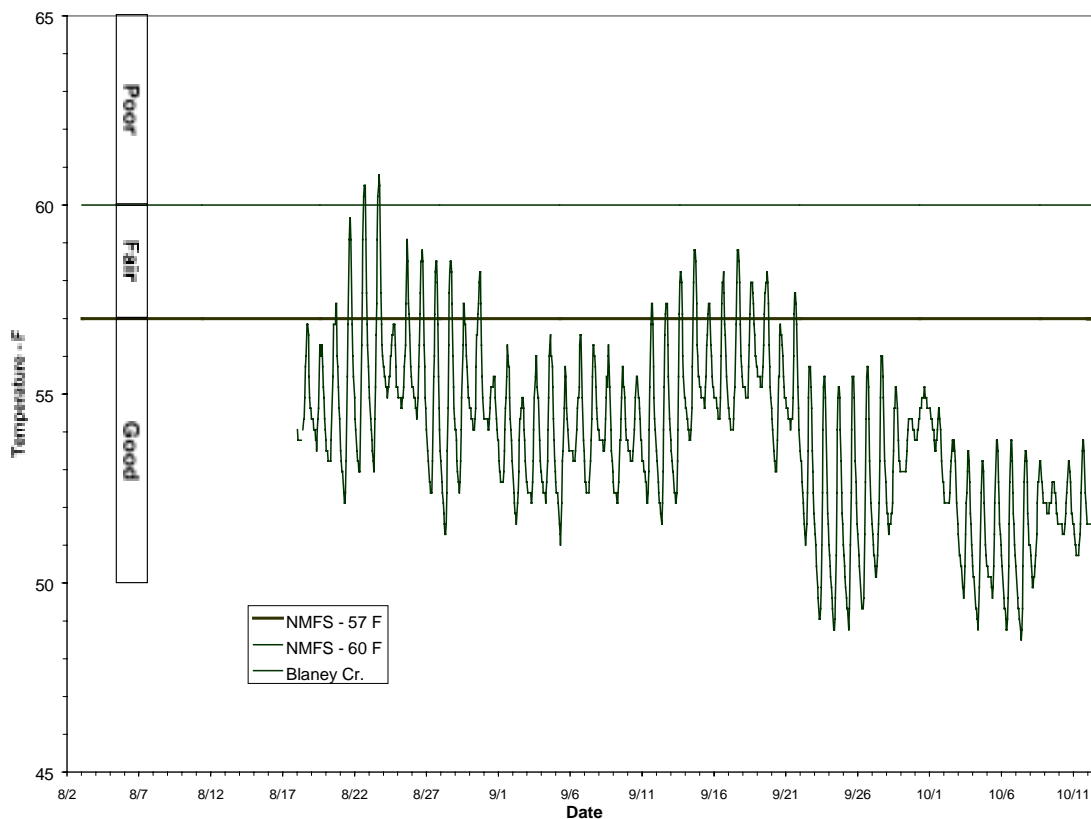
LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
South Fork Grays	0	0.0%	0	0.0%	11	91.7%	1	8.3%	12	100%
Blaney Creek	0	0.0%	0	0.0%	6	100.0%	0	0.0%	6	100%
Total	0	0.0%	0	0.0%	17	94.4%	1	4.2%	18	100%

### Water Quality

Historical data is lacking for water quality in the South Fork Grays and its tributaries. Beginning in 2000 the Wahkiakum Conservation District started to monitor the temperature in Blaney Creek, a tributary to the South Fork Grays River. This monitoring will be conducted annually through 2004. The District may relocate this site to collect information directly on the South Fork Grays River (WCD 2000).

Figure 6 illustrates the temperature data obtained from Blaney Creek during the summer of 2000. Washington State Conservation Commission water temperature criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. State water quality standard for Type AA water is 61.8 degrees Fahrenheit. Stream temperature increase slightly during the summer months, yet stream temperatures remain generally within the fair range and lower than most other streams monitored in the Grays River watershed. Stream temperature begins to decrease with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods.

Figure 6: Blaney Creek - Year 2000 Maximum Hourly Stream Temperature



While this one-year of monitoring determined that water temperatures were generally lower in Blaney Creek than in other monitored Grays River tributaries, TAG members thought that overall water temperatures were elevated in the South Fork Grays River. They also indicated that the South Fork is responsible for a majority of the turbidity observed in the Grays River during winter storm events. The source of this turbidity is thought to be a large active soil failure at approximately RM 3 (TAG).

#### *Water Quantity*

United State Geological Survey maintained a streamflow gauging station on the Grays River immediately downstream of the South Fork Grays (station #14249500) and immediately upstream of the South Fork Grays River (station 14249000). The station downstream of the South Fork operated between 1956 and 1960. The station upstream of the South Fork operated between 1956 and 1975 (Williams 1985).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

Table 60 provides land cover data for the South Fork Grays WAU that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). As Table 60 shows there is almost no late seral forest cover left in the WAU. However, there is a high percentage of mid-seral stage vegetation covering more than 55% of the watershed.

**Table 60: Forest Seral Stage/ Land Cover in the South Fork WAU (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
South Fork Grays	Acres	12	9329	2938	0	8	4478	16,765
	Percent	0.1	55.6	17.5	0	0.1	26.7	100.0

The road density for the South Fork WAU is approximately 3.08 miles of road/square mile. While the WAU is considered hydrologically mature, the high road density places the WAU in the likely impaired category for increased peak flow potential. It will be important to assess changes to the hydrology of the watershed from road development to determine if increased peak flows are affecting channel conditions, especially in light of

the problems identified with streambank and slope instability, heavy sediment loads, and the lack of LWD and pools.

Data is lacking on low flow conditions within the South Fork watershed.

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

Stream surveys in November of 1936 found 6,286 spawning or spawned out chum below the falls in the mainstem Grays (Bryant 1949). Spawning survey data show a sharp decline in chum escapement since 1960, and SASSI (WDF et al. 1993) considers Grays River chum depressed. Grays River coho were also considered depressed. Grays River fall chinook were considered healthy based on escapement trends; however, evidence suggests that few natural fall chinook juveniles are produced in the system (WDF et al. 1993). The winter steelhead stock status in the Grays River was also considered depressed (LCSCI 1998).

### Upper Grays River from Canyon to headwaters

(East Fork Grays River and its tributaries, and Alder, Cabin, Johnson, and Unnamed Creeks)

### *Access*

(Appendix A, Map A-2)

This upper section of the Grays River and its tributaries has many natural barriers and some man-made barriers. Most of these need assessment with standard protocols to evaluate fish passage. Fish passage issues in this section of the Grays River include:

- A culvert is located on an unnamed tributary entering the Grays River at RM 21. The culvert is located under the 7200 road and is approximately 7 feet in diameter and 150 feet long, with a two-foot outlet height and 40 feet of fill over the pipe. There is an estimated one mile of anadromous habitat above this structure before a bedrock chute may impede further passage. TAG members indicate that considerably more habitat exists above the bedrock chute that might be accessible during certain flows if the downstream culvert was removed.
- Fish ladders are located at RM 21.3 and RM 26 on the mainstem Grays River.
- A 10-foot falls is located at RM 24 on the mainstem Grays River.
- A 6 foot falls, caused by an old bridge failure, is located at RM 26 on the mainstem Grays River
- A 15 foot falls occurs at RM 26.5 on the mainstem Grays River

- Alder Creek enters the Grays River at RM 20.5, and there is a 16-foot falls located ½ mile above its confluence with the Grays River. TAG members indicated that low flows might isolate habitats in Alder Creek.
- Cabin Creek has a 5.5-foot high falls, 1.2 miles from its mouth.
- East Fork Grays River enters the Grays River at RM 21.7. There is a 7' falls located 5 miles from its mouth. An unnamed tributary (RM 0.5) has an 8-foot falls at 1,570' and a 10-foot falls at RM 1.4.

### *Floodplain Connectivity*

The upper Grays River and its tributaries flow through canyons and very steep terrain where floodplain development is likely very limited. Splash dams operated in the mainstem Grays River (RM 22.7), approximately 5 miles upstream of the confluence with the South Fork Grays and in the South Fork Grays (Bryant 1949). In many areas across the Pacific Northwest, splash dams left a legacy of eroded streambeds and incised channels that were disconnected from their floodplains (Sedell et al. 1991). Data is lacking on the condition of existing floodplain habitat and how well this habitat is connected to the streams.

### *Bank Erosion*

(Appendix A, Map A12)

Table 61 and Map A-12 provide data on bank erosion from stream surveys conducted by the Wahkiakum Conservation District between 1994 and 1996. Active bank erosion was estimated for every 200-foot segment in 5 percent increments during the surveys. The estimated erosion was calculated by determining the length of the eroding area, both sides of the stream, compared to the 400 feet of total stream bank in the segment. The information collected during the stream surveys does not meet the Conservation Commission's criteria for bank stability since erosion that occurred on outside bends, in areas where the channel was constricted, or where flow was deflected into a bank by local conditions was not noted in the surveys. Only those eroding areas in unexpected locations along straight areas and inside corners were noted. TAG members felt that this survey data is likely best used to identify areas where additional stream stability assessment is needed rather than an accurate picture of streambank stability in the watershed. (see Appendix D for details on how bank erosion was noted).

The majority of the surveyed stream reaches in the upper Grays watershed surveyed rated "good" for bank erosion. There were stream segments where bank erosion problems were identified, particularly in a few reaches of the mainstem Grays River near the confluence with the South Fork Grays, and in the lower end of Mitchell Creek (see Map A-12).

Alder Creek rated "good" overall for bank erosion. Some erosion was observed upstream of the concrete diversion that is used to feed water to a fishpond.

**Table 61: Upper Grays River Bank Erosion (# of reaches and % of total)**

Upper Grays River Bank Erosion (# of reaches and % of total)										
LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River (3)	52	83.9%	6	9.7%	3	4.8%	1	1.6%	62	100%
Alder Creek	2	66.7%	1	33.3%	0	0.0%	0	0.0%	3	100%
East Fork Grays	28	65.1%	12	27.9%	3	7.0%	0	0.0%	43	100%
Mitchell Creek	9	75.0%	1	8.3%	2	16.7%	0	0.0%	12	100%
Sage Creek	4	57.1%	3	42.9%	0	0.0%	0	0.0%	7	100%
Cabin Creek	8	72.7%	3	27.3%	0	0.0%	0	0.0%	11	100%
Total	103	74.6%	26	18.8%	8	5.8%	1	0.7%	138	100%

The East Fork Grays River watershed was surveyed following high flow events in the spring of 1996. Surveyors indicated that most of the erosion they observed could have resulted from these repeated high flow events. Overall, the East Fork Grays River rated “good” for bank erosion. However, several of its tributaries have areas with erosion problems. An unnamed tributary to the East Fork Grays (first left bank tributary upstream for the confluence with the Grays River) has channel instability in its mid-reaches. Surveyors identified areas of severe erosion below and areas of streambank instability above a failed culvert that is located behind a gate signed as a Washington State Department of Fish and Wildlife Experimental Area. The stream is attempting to reestablish itself in the sediment that accumulated above the culvert (WCD 2001). WDFW TAG members indicated that they thought this problem had been addressed.

The first 3,000 feet of Mitchell Creek rated “poor” for bank erosion, while the upper 9,000 feet rated “good”. The “poor” bank stability rating appears to coincide with the relatively unconfined portion of Mitchell Creek flowing through alluvial deposits. These conditions indicate that the stream is free to respond to changes in sediment load or hydrology. The stream surveyors noted that this stream had excellent habitat for fish with good gravels and good pool/riffle sequences. Two very large slides were noted on Mitchell Creek near the 7250 Road.

Sage Creek bank stability was considered “fair” in the first 2,000 feet and then improves further upstream. Like Mitchell Creek, it appears that the first 2,000 feet of Sage Creek is an unconfined stream flowing through alluvial deposits. The creek is paralleled by a railroad grade through the middle segments.

Cabin Creek bank erosion is highly variable. The stream contains series of falls and debris jams. The debris jams diverge flow into the banks resulting in areas with excessive bank erosion.

#### *Side Channel Availability*

The mainstem Grays River through this reach is a single thread channel with little or no side channels observed. In the segments where side channels were observed (5 out of 37

– 1000 foot segments) stream surveyors also noted the presence of high quality habitat for juvenile fish (WCD 2001).

Side channel availability in the East Fork Grays River rated “poor”. However, the lower segment of its tributary streams including Mitchell Creek and an unnamed stream were identified as multi-thread channels. It appears that bedload is accumulating in mid channel bars, resulting in multi-thread channels (WCD 2001).

#### *Substrate Fines*

(Appendix A Map A-13)

Table 62 and Map A-13 provide data on substrate fines condition from Wahkiakum Conservation stream surveys (see Appendix D for an explanation of how conditions were rated). For the upper mainstem Grays River, 30 out of 62 surveyed reaches rated good for substrate fines condition, and 13 reaches rated “poor”. Surveyors noted that several segments had elevated quantities of sand size substrate materials. Only one reach (segment 110) had any significant amount of silt. Sediment conditions varied substantially for the surveyed reaches of the upper Grays River tributaries (see Table 62).

In both Sage and Mitchell Creeks, the majority of surveyed reaches rated “poor” for sediment fines. Sediment fines problems were consistent in the lower reaches of both these streams (WCD 2001). The majority of surveyed reaches in both the East Fork Grays River and Cabin Creek rated “good” for substrate fines. Almost all of the upper tributaries had a high percentage of gravel substrates (WCD 2001). Most of the upper reaches of tributaries in this area are high gradient transport reaches, where fine sediments move quickly through to lower gradient response reaches.

With a number of stream adjacent roads and railroads following the mainstem Grays River and fairly substantial reaches of the East Fork Grays and Mitchell Creek, and road densities above 5.5 miles of roads/square mile in the Mitchell Creek WAU, it is likely inputs of fine sediment inputs could be excessive in this area. The Mitchell Creek WAU also has the second greatest number of stream crossings/square (34.1) of any WAU in the lower Columbia River (WRIAs 25-29)(data from Lewis County GIS 2001).

**Table 62: Upper Grays River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 3	30	48.4%	12	19.4%	13	21.0%	7	11.3%	62	100%
Alder Creek	1	33.3%	1	33.3%	1	33.3%	0	0.0%	3	100%
East Fork Grays River	22	51.2%	17	39.5%	4	9.3%	0	0.0%	43	100%
Mitchell Creek	5	41.7%	1	8.3%	6	50.0%	0	0.0%	12	100%
Sage Creek	1	14.3%	0	0.0%	6	85.7%	0	0.0%	7	100%
Cabin Creek	8	72.7%	3	27.3%	0	0.0%	0	0.0%	11	100%
Total	67	43.6%	34	21.3%	30	33.2%	7	1.9%	138	100.0%

Mass wasting is also considered a significant problem in the Grays watershed (TAG). Examination of USDA Soil Survey Maps found 256 mass failures in the Grays River watershed, creating an overall density of 4.22 mass failures/square mile (Waterstrat 1994). TAG members noted that railroad grades along the East Fork Grays River have experienced numerous slope failures that have led to debris flows. Two very large slides near the 7250 Road, and numerous bank erosion problems, likely add to sediment fines to Mitchell Creek.

#### *Riparian Conditions*

(Appendix A Map A-14)

Table 63 and Map A-14 provide data from Wahkiakum Conservation District stream surveys (see Appendix D for an explanation of how conditions were measured). The majority of the surveyed reaches in the upper Grays River watershed rated “fair” for riparian conditions. Along the upper mainstem Grays River, the majority of surveyed reaches had “poor” riparian conditions. Riparian vegetation along the mainstem is predominantly immature deciduous species with high variable buffer widths (WCD 2001). Stream surveyors determined that the majority of surveyed reaches along both the East Fork Grays and Cabin had “good” riparian conditions.

The tributary streams have generally adequate riparian buffer widths; however, immature riparian vegetation lines many of the surveyed stream segments (WCD 2001). TAG members reported that Alder Creek was clear-cut in the recent past, and that Mitchell Creek experienced two fires in 1978 (TAG). TAG members also indicated that Johnson Creek was logged down to stream banks during the 1970’s.

**Table 63: Upper Grays River Riparian Conditions (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 3	3	4.8%	17	27.4%	35	56.5%	7	11.3%	62	100%
Alder Creek	1	33.3%	1	33.3%	1	33.3%	0	0.0%	3	100%
East Fork Grays River	22	51.2%	20	46.5%	1	2.3%	0	0.0%	43	100%
Mitchell Creek	2	16.7%	8	66.7%	2	16.7%	0	0.0%	12	100%
Sage Creek	0	0.0%	6	85.7%	1	14.3%	0	0.0%	7	100%
Cabin Creek	8	72.7%	3	27.3%	0	0.0%	0	0.0%	11	100%
Total	36	29.8%	55	47.8%	40	20.5%	7	1.9%	138	100%

#### *Large Woody Debris (LWD)*

(Appendix A Map A-15)

Only 5 out of 138 surveyed reaches in the upper Grays watershed met the criteria for having “good” LWD conditions. 85 surveyed stream segments rated “poor”. No LWD

was observed in several 1,000-foot segments of the mainstem Grays River. The LWD that was noted in the mainstem Grays was located in logjams or was deposited on floodplains well outside the active channel (WCD 2001). One logjam, at RM 17.5 (reach 93) may have re-channeled the Grays River. Another logjam on the Grays at RM 25 measured 20 feet high x 300 feet long.

**Table 64: Upper Grays River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 3	1	1.6%	0	0.0%	27	43.5%	34	54.8%	62	100%
Alder Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
East Fork Grays River	1	2.3%	5	11.6%	30	69.8%	7	16.3%	43	100%
Mitchell Creek	1	8.3%	1	8.3%	9	75.0%	1	8.3%	12	100%
Sage Creek	2	28.6%	0	0.0%	5	71.4%	0	0.0%	7	100%
Cabin Creek	0	0.0%	0	0.0%	11	100.0%	0	0.0%	11	100%
Total	5	6.8%	6	3.3%	85	76.6%	42	13.2%	138	100%

Some segments rated “fair” or “good” for LWD in the mid- to upper-segments of tributary streams including East Fork Grays River, Mitchell Creek, and Sage Creek. As with the upper Grays River, LWD in the tributaries was observed on the flood plains well outside the active channel. A majority of the wood functioning in the streams was observed in debris jams. An extremely large jam 1.5 miles from the mouth of Mitchell Creek is thought to have rerouted the entire channel.

Cabin Creek rated “poor” for LWD (see Table 64). The LWD observed consisted of a mix of conifer and deciduous species although a majority of the material was located in jams up to 10 feet in height. Most of the LWD in Cabin Creek appears to be have been delivered to the stream through mass wasting. A seventy-foot wide slide was observed one-half mile from the mouth, which took out a road culvert but delivered large quantities of LWD to the stream (WCD 2001).

#### *Percent Pool*

(Appendix A Map A-16)

The majority of all surveyed reaches in the upper Grays River watershed rated “poor” for the percentage of pool habitat (see Table 65). The mainstem Grays River through the canyon has good quality pools that are mostly bedrock controlled (TAG). However, overall the mainstem upper Grays River rated “poor” for the percentage of pool habitat (see Appendix B for habitat rating standards).

The percentage of pool habitat in Alder Creek rated “fair” in the first 1,000-feet of the stream. Fewer pools were observed in the upstream segments. The segments of the East Fork Grays River downstream of Sage Creek rated “fair” or “good” for percent pool, but

overall percent pool was “poor”. All surveyed reaches of Mitchell Creek and 5 out of 6 surveyed reaches of Sage Creek rated “poor” for the percentage of pools.

**Table 65: Upper Grays River Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Grays River 3	11	17.7%	4	6.5%	37	59.7%	10	16.1%	62	100%
Alder Creek	0	0.0%	1	33.3%	1	33.3%	1	33.3%	3	100%
East Fork Grays	7	16.3%	14	32.6%	19	44.2%	3	7.0%	43	100%
Mitchell Creek	0	0.0%	0	0.0%	12	100.0%	0	0.0%	12	100%
Sage Creek	1	14.3%	0	0.0%	6	85.7%	0	0.0%	7	100%
Cabin Creek	2	18.2%	4	36.4%	5	45.5%	0	0.0%	11	100%
Total	21	15.2%	23	16.7%	80	58.0%	14	10.1%	138	100%

The lack of pool habitat in this area may be related to the lack of LWD in the system (Swanston et al. 1991).

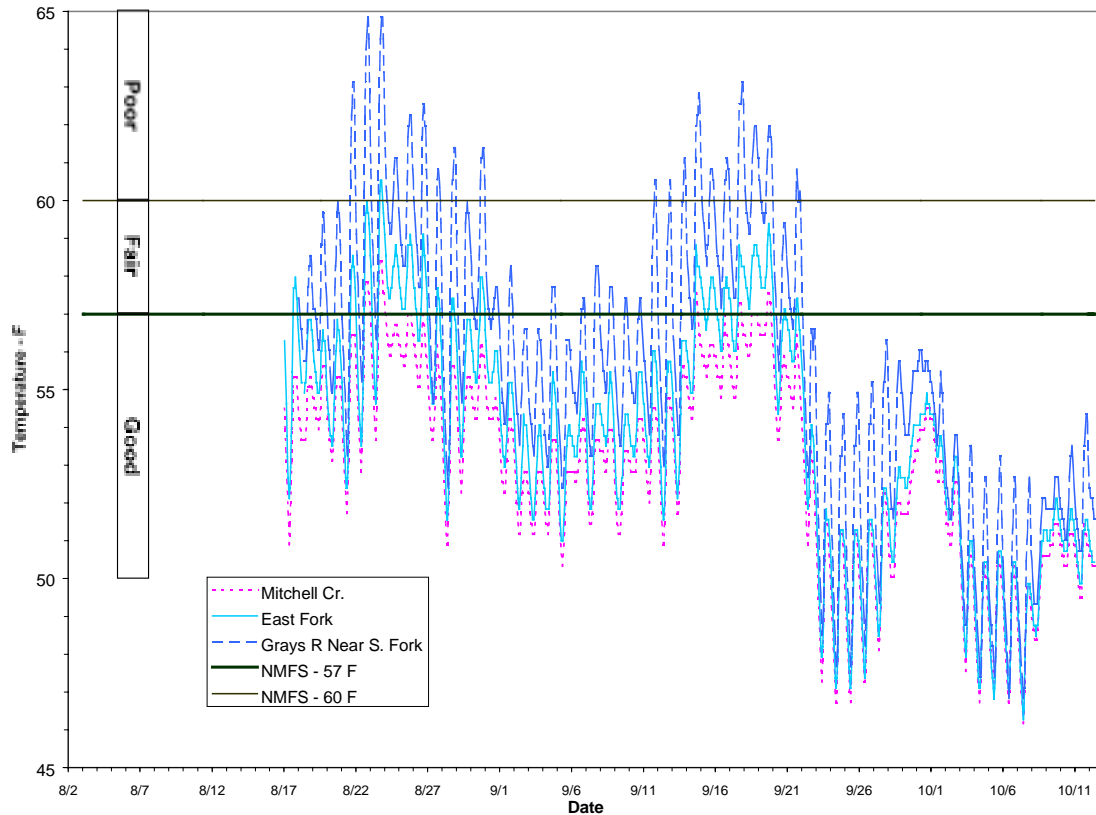
#### *Water Quality*

A USGS stream gauging station operated from 1964-74 above the South Fork at RM 17.8. Water quality data is also available from a gauging station at RM 14.5 (below the South Fork), from 1956-60.

Beginning in 2000, the Wahkiakum Conservation District began monitoring water temperature in the Grays River upstream of the South Fork, East Fork Grays, and in Mitchell Creek. This monitoring is to be conducted annually through 2004 (WCD 2000).

Figure 7 illustrates the temperature data obtained from the Upper Grays River sites during the summer of 2000. Washington State Conservation Commission’s water temperature criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. An additional line could be plotted to highlight the state water quality standard for Type AA water of 61.8° Fahrenheit. Stream water temperatures increase well above acceptable levels during the summer months on the upper Grays River near the confluence with the South Fork. On the other hand, the upper monitoring sites on the East Fork Grays River and Mitchell Creek found only slight elevation in summer stream temperatures (see Figure 7). The mainstem Grays River near the South Fork is fairly wide open and is oriented north-south. Whereas the smaller streams, East Fork, Mitchell, and Blaney Creek, have east-west orientations, narrow valleys, and improved riparian conditions that likely contribute to cooler water temperatures throughout the year (see Figure 6 and Figure 7). At all monitored sites, stream temperatures decrease with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Coho salmon, may contend with temperatures in the “fair” range as they first enter the system.

**Figure 7: Upper Grays River Sites - Year 2000 Hourly Maximum Stream Temperature**



### *Water Quantity*

United State Geological Survey maintained a streamflow gauging station on the Grays River immediately downstream of the South Fork Grays (station #14249500) and immediately upstream of the South Fork Grays River (station 14249000). The station downstream of the South Fork confluence operated between 1956 and 1960. The station upstream of the South Fork confluence operated between 1956 and 1975 (Williams, 1985).

Substantial changes from historic conditions have occurred in the land cover of the Mitchell Creek Watershed Administrative Unit (WAU)(same as the Upper Grays watershed). Table 66 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 66 that 54% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. Only 0.1% of the land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the watershed of greater than 5.5

miles of road/square mile also increase channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-18 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. As Map A-18 illustrates, the forest cover in the Mitchell Creek WAU is considered hydrologically immature and road densities well exceed 3 miles of road/square mile, raising concerns for increased peak flows in streams in this area.

TAG members mentioned that the Mitchell Creek watershed had two large fires in 1978. They also noted that many of the disturbed areas within the upper Grays River watershed were now covered with healthy young conifers.

**Table 66: Forest Seral Stage/ Land Cover in the Mitchell Creek WAU (Upper Grays)(Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
Mitchell Creek	Acres	19	11,727	6,143	0	0	7,657	25,547
	Percent	0.1	45.9	24.0	0	0	30.0	100.0

Data is lacking on low flow conditions within the upper Grays River watershed

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

Stream surveys in November of 1936 found 6,286 spawning or spawned out chum below the falls in the mainstem Grays (Bryant 1949). Spawning survey data show a sharp decline in chum escapement since 1960, and SASSI (WDF et al. 1993) considers Grays River chum depressed. Grays River coho were also considered depressed. Grays River fall chinook were considered healthy based on escapement trends; however, evidence suggests that few natural fall chinook juveniles are produced in the system (WDF et al.

1993). The winter steelhead stock status in the Grays River was also considered depressed (LCSCI 1998).

### **Skamokawa / Elochoman Subbasin**

The Skamokawa – Elochoman subbasin has been broken down into 5 principal watersheds to better display data collected during stream surveys. The watersheds are listed below.

- **Jim Crow Creek Watershed** (Fink Creek)
- **Skamokawa Creek Watershed** (Skamokawa Creek, Left Fork Skamokawa, Quarry Creeks, West Valley Creek, Cadman Creek, Wilson Creek, Bell Canyon Creek, Falk Creek, Pollard Creek, West Fork Skamokawa, Eggman Creek, Kelly Creek, Standard Creek, and McDonald Creek)
- **Alger Creek Watershed**
- **Birnie Creek Watershed**
- **Elochoman River Watershed** (Nelson Creek, Beaver Creek, Duck Creek, Clear Creek, Rock Creek, West Fork, North Fork, East Fork and Otter Creek).

#### Jim Crow Creek

##### *Access*

(Appendix A, Map A3)

No access issues were identified within the Jim Crow Creek watershed.

##### *Floodplain Connectivity*

Jim Crow Creek is tidally influenced for the first mile. Although specific data regarding stream entrenchment is not available the stream is not diked and large wetland areas were noted during stream surveys suggesting good floodplain connectivity. Upper segments may be slightly entrenched based on observations of LWD primarily suspended over the channel (WCD 2001).

##### *Side Channel Availability*

Stream survey data was not collected that allowed direct application of Limiting Factors Rating Criteria for a common assessment of side channel availability across watersheds. However, survey notes were used to identify and qualitatively assess side channels. Survey data indicates that Jim Crow Creek is a single thread stream. Only three side channels were noted in the stream survey data. One is located in the first thousand feet of Fink Creek and two in the mid- to upper-segments of Jim Crow Creek.

### *Bank Erosion / Bank Stability*

(Appendix A, Map A12)

Table 67 provides data that was collected by Wahkiakum Conservation District on actively eroding stream banks in the Jim Crow Creek watershed. Surveyors noted few areas of bank erosion, and all surveyed reaches in Jim Crow Creek rated “good” for bank erosion.

**Table 67: Jim Crow Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total		
	#	%	#	%	#	%	#	%	#	%	%
Fink Cr.	5	100.0%	0	0.0%	0	0.0%	0	0.0%	5	5	100%
Jim Crow Cr.	31	100.0%	0	0.0%	0	0.0%	0	0.0%	31	31	100%
	36	100.0%	0	0.0%	0	0.0%	0	0.0%	36	36	100%

### *Substrate Fines*

(Appendix A, Map A13)

Table 68 provides data on fine sediment conditions from Wahkiakum Conservation District stream surveys (WCD 2001). The majority of surveyed reaches in both Jim Crow and Fink Creeks had excessive levels of fine sediments. The lower reaches of Jim Crow Creek are tidally influenced and naturally dominated by fine sediment substrates. As stream gradient increases, the percentage of gravel substrates increased significantly and the percentage of fine sediment decreased. The rock in the stream was predominantly from sedimentary sources and breaks down readily into sand and silt size particles.

**Table 68: Jim Crow Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Fink Cr.	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
Jim Crow Cr.	8	25.8%	4	12.9%	19	61.3%	0	0.0%	31	100%
Total	8	12.9%	4	6.5%	24	80.6%	0	0.0%	36	100%

The Conservation Commission’s Habitat Rating Standards (see Appendix B) use road densities as a surrogate for measuring fine sediment inputs to stream systems. Road densities greater than 3 miles/square mile are considered “poor” by this standard. There are a total of approximately 39.3 miles of road in the sub-watershed. This results in a road density of 5.14 miles/square mile, where 45 percent are active mainhaul roads. The road network seems to be well established with few signs of washout because of the well-established vegetation on side slopes and shoulders and the adequate design, size, and

placement of ditches and culverts (Waterstrat 1994). Forty-three mass failures were noted on the 1986 Soil Survey Maps; these were primarily on Zenker silt loam with 30-65 percent slope. The overall density of mass failures is 5.60-failures/square mile (Waterstrat 1994). The Jim Crow Creek watershed has the second highest road density and third highest mass failures rates of 13 watersheds assessed by Waterstrat (1994) in Wahkiakum County.

### *Riparian*

(Appendix A, Map A14)

Table 69 provides data on riparian conditions within the Jim Crow creek watershed from Wahkiakum Conservation District stream surveys. Only 2 out of 36 surveyed reaches had “good” riparian conditions; both reaches were on Jim Crow Creek. All 5 surveyed reaches along Fink Creek rated “poor” for riparian conditions. Buffer widths were generally adequate throughout the watershed (200+ feet). Riparian vegetation along the lower reaches of Jim Crow Creek contained mostly deciduous species, yet conifer species are intermixed throughout these lower segments. Where a balanced mix of species occurs, the age class is sufficient to generate a “fair” rating. Conifers are the dominant species in the upper watersheds; however, most of the riparian zones contain immature trees resulting in “fair” riparian ratings.

**Table 69: Jim Crow Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Fink Cr.	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
Jim Crow Cr.	2	6.5%	20	64.5%	9	29.0%	0	0.0%	31	100%
Total	2	3.2%	20	32.3%	14	64.5%	0	0.0%	36	100%

Ninety-nine percent of the Jim Crow Creek watershed is privately owned industrial forest or state lands. Timber age classes are characterized as: one percent is 50+ years old, 95 percent is 11-50 years old, and 4 percent is 0-10 years old. The remaining percentage can best be described as tidal wetlands rather than agricultural lands because they are regularly inundated with water and are vegetated primarily by hydric plants. Neither domestic farm animals nor fences to prevent animal access to stream banks were observed during stream surveys in 1993 (Waterstrat 1994).

### *Large Woody Debris*

(Appendix A Map A-15)

Table 70 provides data on LWD conditions in Jim Crow Creek. Large Woody Debris rated “poor” throughout the watershed, although the tidal area was noted as having some distribution of LWD (WCD 2001). Within the mid-segments (9,000 – 20,000 feet) the amount of LWD increased, however, most of the LWD consisted of small diameter woody material and the segments rated “poor”. Throughout the surveyed segments wood

delivery is thought to be through windfall. Numerous debris jams were observed in Fink Creek (WCD 2001).

**Table 70: Jim Crow Creek Large Woody Debris (LWD)(# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Fink Cr.	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
Jim Crow Cr.	0	0.0%	0	0.0%	30	96.8%	1	3.2%	31	100%
Total	0	0.0%	0	0.0%	35	98.4%	1	1.6%	36	100%

#### *Percent Pool/Pool Frequency*

Table 71 provides data on the percent of pool habitat in Jim Crow Creek (see Appendix B and D for an explanation of how percent was measured and categorized). The percentage of pool habitat rated “poor” throughout the watershed with exception of several segments above the confluence with Fink Creek. The increase in pool habitat in these segments appears to correspond with observed beaver activity and the delivery of small diameter woody debris to the stream.

**Table 71: Jim Crow Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		NC		Total	
	#	%	#	%	#	%	#	%	#	%
Fink Cr.	0	0.0%	0	0.0%	5	100.0%	0	0.0%	100%	5
Jim Crow Cr.	1	3.2%	5	16.1%	25	80.6%	0	0.0%	100%	31
Total	1	1.6%	5	8.1%	30	90.3%	0	0.0%	100%	36

#### *Water Quality*

Wahkiakum Conservation District began monitoring the temperature in Jim Crow Creek in 2000. Monitoring is planned annually through 2004. The district was unable to recover the thermograph from the site in 2000 so no data is available.

#### *Water Quantity*

Data is generally lacking on streamflow characteristics for the Jim Crow Creek watershed, other than from a United State Geological Survey gaging station on Jim Crow Creek immediately upstream of the Fink Creek tributary (station #14248200) that operated between 1964 and 1974.

#### *Biological Processes*

There was no information on escapement for most species in Jim Crow Creek. However, it is likely that escapement is well below historic levels, and the lack of nutrients may be limiting production in the watershed. Beaver activity was observed in the segments at and above the Jim Crow Creek’s confluence with Fink Creek. WDFW TAG members

indicated that chum surveys have been conducted recently on Jim Crow Creek. The data should soon be available. Industry TAG members indicated that they observed chum salmon in both Jim Crow Creek and Fink Creek in 2000. Fish were observed spawning in the vicinity of Fink Creek.

### Skamokawa Creek

#### *Access*

(Appendix A, Map A3)

Culverts and tidegates block a little over 6 miles of the 59 miles of presumed, and potential anadromous habitat in Skamokawa Creek Subbasin; or approximately 10% of the subbasin. The following are fish passage barriers identified by TAG members that need assessment:

- Dead Slough has a tide gate at the lower end (RM .2) and a gate valve on the upper end (RM 1.7). Any alterations to the existing tidegates could potentially impact water quality in Skamokawa Creek and will require careful consideration before any modifications are proposed (TAG).
- Eggman Creek culvert, RM 2.1, has an outfall drop of three feet;
- Kelly Creek, RM 0.1, and its Unnamed Creek have culverts that are barriers. TAG indicated that the upper watershed is in good timbered condition and supports natural wetlands that could be productive habitat;
- Quarry Creek culvert, RM 0.1, has a nine- percent gradient. TAG members indicated that a debris torrent corrected the culvert problem but now there is a pile of debris that may restrict passage;
- Several unnamed tributaries to Standard Creek have culvert passage problems;
- A tributary to Elk Horn Creek (RM 01) has a problem culvert with a three-foot outfall and a five-percent gradient;
- Beaver Dam Creek (Kelly Creek on USGS 7.5-minute maps) culvert located under State Route 4 in West Valley may impair passage to 1-2 miles of habitat;

Wahkiakum Conservation District is in the process of collecting culvert assessment data on many of the county culverts located in the Skamokawa-Elochoman subbasin. This data should be available in the near future to assist with assessment needs.

#### *Floodplain Connectivity*

Skamokawa Creek has been channelized from its mouth to RM 1.7. This reach of stream has been diverted from its original, naturally-meandering channel. There is a tide gate at the lower end and a gate valve at the upper end of the original channel. The TAG recognized the need/opportunity to assess some level of reconnection of Skamokawa Creek and Dead Slough for migration and rearing habitat. From RM 1.7 to Standard Creek (RM 6.6), Skamokawa Creek is entrenched and flows through agricultural land (WCD 2001).

Wilson Creek is diked on the left bank for the first 1000 feet. Wilson, Falk, Pollard, and Bell Canyon Creeks are highly entrenched through areas of agricultural land use (WCD 2001).

West Fork Skamokawa Creek is diked on the left bank from its mouth to RM 0.7. The West Fork Skamokawa Creek and its tributaries are highly entrenched through areas of agriculture land use (WCD 2001).

The condition of floodplain connectivity on Eggman Creek was unknown.

#### *Side Channel Availability*

Side channel availability in this watershed is largely unknown (TAG). Many of the streams in this watershed are highly entrenched and would have limited opportunity to form side channels.

Stream survey data was not collected that allowed direct application of Limiting Factors Rating Criteria for a common assessment across watersheds. However, survey notes were used to identify and qualitatively assess side channels. Survey data indicates that side channels exist in the upper segments of tributary streams including Wilson, Falk, and Left Fork Skamokawa Creeks. Side channels were observed in stream segments on the mainstem Skamokawa between Wilson Creek and Left Fork Skamokawa; however, these were noted as being highly transient in nature. No side channels were noted in the West Fork Skamokawa Creek.

#### *Bank Erosion / Bank Stability*

(Appendix A, Map A12)

Table 72 and Table 73 provide data on actively eroding banks noted during Wahkiakum Conservation District stream surveys conducted between 1994-1996 on Skamokawa Creek and its tributaries (see Appendix D for a description of how bank erosion was measured). For the vast majority (over 90% on the mainstem and 67% on West Valley) of the surveyed reaches in the Skamokawa Creek watershed (see Table 72) surveyors found <10% actively eroding streambanks.

In 1991, approximately 5.5 miles (11 miles of streambank) of Type 2 and 3 streams were field inventoried by Wahkiakum Conservation District staff in the agricultural areas of the Middle Valley of Skamokawa Creek (Ludwig 1992). Six of the 11 surveyed miles of stream had stable and well-vegetated banks and 1.8 miles were stable but lacked vegetation. Eroding streambanks were found along three miles of stream or about 28% of the total bank area examined. On Skamokawa Creek, excluding Falk and Pollard Creeks, bank erosion occurs on 34% of the bank area in agricultural land use (Ludwig 1992).

From its mouth to Standard Creek (RM 6.6), Skamokawa Creek has been hardened with riprap in numerous locations. Some bank erosion was observed between the hardened

areas, mostly in agricultural land (WCD 2001). TAG members did indicate that the bank stability should be considered poor throughout the agriculture sections of Skamokawa Creek. This reflects several stream conditions that influence bank stability. The channel is highly incised throughout most of the agriculture land use, stream banks are alluvial soils characterized as sandy and silty loam, and riparian vegetation is limited throughout the area.

Wilson Creek had some serious bank stability problems in the winter of 1998, especially in the lower reaches (TAG). TAG members noted that bank stability concerns in Wilson Creek were likely related to timber harvest in upper Wilson Creek during the 1970's and 1980's. Mud Creek was the only creek surveyed where bank erosion fell into the "fair" and "poor" categories.

**Table 72: Mainstem Skamokawa Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Bell Canyon Cr.	2	66.7%	1	33.3%	0	0.0%	0	0.0%	3	100%
Falk Cr.	28	84.8%	4	12.1%	0	0.0%	1	3.0%	33	100%
Left Fork Skamokawa	4	80.0%	1	20.0%	0	0.0%	0	0.0%	5	100%
Middle Valley Skamokawa	5	100.0%	0	0.0%	0	0.0%	0	0.0%	5	100%
North F. Wilson Cr.	3	100.0%	0	0.0%	0	0.0%	0	0.0%	3	100%
Pollard Cr.	6	85.7%	1	14.3%	0	0.0%	0	0.0%	7	100%
Quarry Cr.	4	100.0%	0	0.0%	0	0.0%	0	0.0%	4	100%
Skamokawa Cr	36	92.3%	3	7.7%	0	0.0%	0	0.0%	39	100%
Standard Cr.	7	100.0%	0	0.0%	0	0.0%	0	0.0%	7	100%
Wilson Cr.	38	92.7%	3	7.3%	0	0.0%	0	0.0%	41	100%
Total	133	90.2%	13	9.5%	0	0.0%	1	0.3%	147	100%

**Table 73: West Valley Skamokawa Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Eggman Cr.	12	80.0%	3	20.0%	0	0.0%	0	0.0%	15	100%
Mud Trib	0	0.0%	1	50.0%	1	50.0%	0	0.0%	2	100%
West Fork Skamokawa	15	100.0%	0	0.0%	0	0.0%	0	0.0%	15	100%
West Valley Cr.	31	88.6%	3	8.6%	1	2.9%	0	0.0%	35	100%
Total	58	67.1%	7	19.6%	2	13.2%	0	0.0%	67	100%

### *Substrate Fines*

(Appendix A, Map A13)

Table 74 and Table 75 provide data from Wahkiakum Conservation District stream surveys on substrate fines conditions in the Skamokawa Creek watershed. A majority of all the surveyed reaches had excessive amounts of substrate fines and fell into “poor” category. This watershed contains steep slopes underlain by sedimentary parent rock that is prone to surficial and deep-seated mass failures (Ludwig 1992). Seventy mass failures were noted on the 1986 Soil Survey Maps in the West Fork Skamokawa subwatershed, and 134 were noted in the Wilson Creek. The Wilson Creek subwatershed had by far the highest number of mass failures/square mile of the 13 watersheds assessed by Waterstrat (1994) in Wahkiakum County. At 6.60-failures/square mile, the West Fork Skamokawa subwatershed had the second highest number of mass failures/square mile. In February 1990, a landslide on “KM” mountain closed State Route 4 for eight months (Waterstrat 1994).

High road densities in the Skamokawa Creek watershed add to the potential for mass wasting. There are a total of approximately 43 miles of road in the West Fork Skamokawa subwatershed and 49 miles of roads in the Wilson Creek subwatershed. This results in a road density of 4.42 miles/square mile for the West Fork Skamokawa and 4.77 roads/square mile in the Wilson Creek watersheds. The Conservation Commission’s Habitat Rating Standards (see Appendix B) use road densities as a surrogate for measuring fine sediment inputs to stream systems. Road densities greater than 3 miles/square mile are considered “poor” by this standard.

**Table 74: Middle Valley Skamokawa Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Bell Canyon Cr.	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Falk Cr.	8	24.2%	3	9.1%	22	66.7%	0	0.0%	33	100%
Left Fork Skamokawa	2	40.0%	2	40.0%	1	20.0%	0	0.0%	5	100%
Middle Valley Skamokawa	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
North F. Wilson Cr.	3	100.0%	0	0.0%	0	0.0%	0	0.0%	3	100%
Pollard Cr.	1	14.3%	0	0.0%	6	85.7%	0	0.0%	7	100%
Quarry Cr.	0	0.0%	0	0.0%	4	100.0%	0	0.0%	4	100%
Skamokawa Cr	4	10.3%	10	25.6%	25	64.1%	0	0.0%	39	100%
Standard Cr.	2	28.6%	0	0.0%	5	71.4%	0	0.0%	7	100%
Wilson Cr.	7	17.1%	3	7.3%	31	75.6%	0	0.0%	41	100%
Total	27	23.4%	18	8.2%	102	68.4%	0	0.0%	147	100%

Skamokawa Creek is tidally influenced and has predominantly fine sediments from the mouth to its confluence with the Left Fork Skamokawa. The lower gradient segments of all the tributary streams rated “poor”. Stream surveys found that as stream gradient increased in these tributaries, the percentage of fine sediments decreased (WCD 2001).

All surveyed reaches of Quarry, Bell Canyon, and Middle Fork Skamokawa Creeks had “poor” substrate fines ratings throughout their surveyed reaches. Wilson Creek had a “poor” fine-sediment rating from its mouth to RM 6.6. Above this point, the substrate fines conditions improved to “good”. All surveyed reaches of the North Fork Wilson Creek has “good” ratings.

Falk Creek had excessive sediment fines from its mouth to RM 3.5. Conditions improved upstream, with 8 reaches rating “good” and 3 reaches “fair”. Pollard Creek had a “poor” rating for 6,000 feet out of the 7,000 feet surveyed.

West Fork Skamokawa Creek rated “poor” for fine sediment conditions in 13 of 15 surveyed reaches (see Table 75). Sediment fines were also a problem in Cadman and Eggman Creeks, and West Valley Creek sediment fines rated “poor” from the mouth to RM 4. Sediment fines condition improved in West Valley Creek to “fair” and “good” from RM 4 to the end of the survey at RM 5.

**Table 75: West Valley Skamokawa Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Eggman Cr.	2	13.3%	3	20.0%	10	66.7%	0	0.0%	15	100%
Mud Trib	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
West Fork Skamokawa	1	6.7%	1	6.7%	13	86.7%	0	0.0%	15	100%
West Valley Cr.	3	8.6%	3	8.6%	29	82.9%	0	0.0%	35	100%
Total	6	7.1%	7	8.8%	54	84.0%	0	0.0%	67	100%

### *Riparian*

(Appendix A, Map A14)

Table 76 and Table 77 provide data on riparian conditions from Wahkiakum Conservation District stream surveys along the mainstem Skamokawa Creek and West Valley Creek subwatersheds. A majority of the surveyed reaches in both sub-watersheds had “poor” riparian conditions. All of the surveyed reaches along Skamokawa, Quarry, Bell Canyon, and Middle Valley Skamokawa Creeks rated “poor” for riparian conditions. Agricultural activities and dikes limit riparian function along the tidally influenced reaches of Skamokawa Creek (WCD 2001). Dikes are typically maintained to prevent vegetation growth. From the tidal area to Standard Creek (RM 2.2 to 6.6), Middle Valley Skamokawa Creek has poor riparian zones, dominated by deciduous trees and narrow

buffers. In the upper segments, buffer width improves but deciduous species are still dominant.

Wilson Creek had “poor” riparian conditions along most of the surveyed length. The lower segments are in agriculture land use and typically have narrow buffer widths dominated by deciduous species. In the upper segments, riparian buffer width improves but deciduous trees are still the dominant species.

Falk Creek (lower 3 miles) and Pollard Creek (lower half mile) rated “poor” for riparian conditions through the agricultural land use areas due to minimal buffer widths. Riparian conditions improve in forested use areas. The “fair” reaches on these streams exhibited good buffer widths and a good mix of conifer and deciduous species. However, the riparian zones generally contained immature trees.

Wahkiakum Conservation District is currently working with three landowners to improve riparian conditions in areas of agricultural land use through the Conservation Reserve Enhanced Program. Two of these sites are contiguous and are located predominantly on Falk and Pollard Creek, with some activity also along Wilson and Middle Valley Skamokawa Creeks. These two combined projects will restore riparian vegetation on approximately 55 acres. The third site will restore riparian vegetation on approximately 5 acres adjacent to the Middle Valley Skamokawa Creek at the upper extent of agriculture land use.

**Table 76: Middle Valley Skamokawa Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Bell Canyon Cr.	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Falk Cr.	1	3.0%	20	60.6%	12	36.4%	0	0.0%	33	100%
Left Fork Skamokawa	2	40.0%	0	0.0%	3	60.0%	0	0.0%	5	100%
Middle Valley Skamokawa	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
North F. Wilson Cr.	0	0.0%	1	33.3%	2	66.7%	0	0.0%	3	100%
Pollard Cr.	0	0.0%	3	42.9%	4	57.1%	0	0.0%	7	100%
Quarry Cr.	0	0.0%	0	0.0%	4	100.0%	0	0.0%	4	100%
Skamokawa Cr	0	0.0%	0	0.0%	39	100.0%	0	0.0%	39	100%
Standard Cr.	4	57.1%	3	42.9%	0	0.0%	0	0.0%	7	100%
Wilson Cr.	2	4.9%	2	4.9%	37	90.2%	0	0.0%	41	100%
Total	9	10.5%	29	18.5%	109	71.0%	0	0.0%	147	100%

Crippen Creek had riparian vegetation for the first 0.6 miles, with conditions improving to “fair” for the last 0.4 miles of the survey. Buffers in this reach were 200 feet wide with 90 percent conifers. A majority of Standard Creek’s riparian corridors had a 200-foot buffer on both sides of the creek with approximately 80 percent 20-inch diameter

conifers. Both the survey data and the TAG indicated that Standard Creek probably has the best riparian conditions in the entire watershed.

West Fork Skamokawa Creek had very few trees in the riparian zones along the lower 2 miles due to agricultural practices (see Table 77). The forested lands above this reach had 200-foot buffers, with the conifer component ranging from 10 to 70 percent. Eggman Creek generally had no trees in the first 0.7 mile because of agricultural practices. Above this area, the riparian zone is 200-feet wide, with a good mix of conifer and deciduous species; however, the trees are predominately immature. West Valley Creek had essentially no riparian vegetation along most of the surveyed reaches. Cadman Creek had 200-foot riparian zones containing predominately deciduous trees (WCD 2001).

**Table 77: West Valley Skamokawa Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Eggman Cr.	0	0.0%	6	40.0%	9	60.0%	0	0.0%	15	100%
Mud Trib	0	0.0%	2	100.0%	0	0.0%	0	0.0%	2	100%
West Fork Skamokawa	1	6.7%	1	6.7%	13	86.7%	0	0.0%	15	100%
West Valley Cr.	0	0.0%	3	8.6%	32	91.4%	0	0.0%	35	100%
Total	1	1.7%	12	38.8%	54	59.5%	0	0.0%	67	100%

According to Waterstrat (1994) 94 percent of the West Fork Skamokawa subbasin is privately owned industrial forestlands; 9 percent is 50+ years old, 68 percent is 11-50 years old, and 23 percent is 0-10 years old. The remaining 6% is used for agricultural and/or residential purposes. Based on field observation, the density of farm animals is estimated to be 0.04 animals/acre. The riparian condition was noted as good along only 22 percent of the stream banks. Very few areas are fenced to keep animals from the creek (Waterstrat 1994).

Approximately 8 percent of the Wilson Creek subbasin is agricultural and/or residential development. Based on field counts the average animal density is estimated at 0.47 animals per acre. No fencing to protect the stream from animal access was visible along 47 percent of the stream bank; 15 percent of the stream bank is in good condition in the lower reaches. State and industrial forest companies own the remaining 92 percent of the subbasin; 36 percent is 50+ years old, 47 percent is 11-50 years old, and 16 percent is 0-10 years old (Waterstrat 1994).

In a watershed study completed in 1992, Ludwig reported the following findings:

- ◆ The Middle Valley Skamokawa Creek watershed is considered to be in a general state of good forest management.

- ◆ The major land owners have been conscientious in conforming to the requirements of the Washington State Forest Practices Act as regulated from 1974 to August 1, 1992.
- ◆ The landowners of the farm areas can assist in good management on their portion of the watershed by managing vegetation in the riparian zone, controlling animal access and replanting of vegetation.
- ◆ Water quality can be improved by limiting direct animal access to all areas of the stream and by over-wintering animals on land areas with low potential for surface water runoff.

### *Large Woody Debris*

(Appendix A, Map A15)

Table 78 and Table 79 provide data on large woody debris (LWD) quantities from Wahkiakum County Conservation District stream surveys. LWD throughout this subbasin rated “poor”, except for two reaches in Mud Creek and one in Eggman Creek. Where LWD exists, hardwood is the dominant material. The stream survey reported “poor” amounts of LWD in Standard, McDonald, and Falk creeks, especially in the agricultural areas. Although they still rated “poor”, the upper segments of Wilson Creek, McDonald Creek, and Falk Creek had greater amounts of LWD. Many logjams, consisting of mostly deciduous trees, were reported in Falk Creek above the agricultural area.

**Table 78: Middle Valley Skamokawa Creek Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Bell Canyon Cr.	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Falk Cr.	0	0.0%	0	0.0%	28	84.8%	5	15.2%	33	100%
Left Fork Skamokawa	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
Middle Valley Skamokawa	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
North F. Wilson Cr.	0	0.0%	2	66.7%	1	33.3%	0	0.0%	3	100%
Pollard Cr.	0	0.0%	0	0.0%	7	100.0%	0	0.0%	7	100%
Quarry Cr.	0	0.0%	0	0.0%	4	100.0%	0	0.0%	4	100%
Skamokawa Cr	0	0.0%	3	7.7%	35	89.7%	1	2.6%	39	100%
Standard Cr.	0	0.0%	0	0.0%	7	100.0%	0	0.0%	7	100%
Wilson Cr.	0	0.0%	2	4.9%	38	92.7%	1	2.4%	41	100%
Total	0	0.0%	7	7.9%	133	90.1%	7	2.0%	147	100%

TAG members indicated that the riparian corridors along Standard and McDonald Creeks had some of the best conditions in the subbasin with the potential to provide both near and long-term LWD recruitment. Two of three surveyed reaches of the North Fork of Wilson Creek had “fair” levels of LWD (see Table 78).

TAG members noted that Wilson Creek, the mainstem Skamokawa above tidewater, and Left Fork Skamokawa would likely respond well to LWD placement. They also expressed concern that the existing riparian vegetation in these areas would not be able to provide for long term LWD recruitment.

West Valley Skamokawa Creek rated “poor” for LWD (see Table 79). In many of the lower segments no LWD was observed. Eggman Creek and its tributaries are the only exception. Delivery of LWD to Eggman Creek likely occurred through mass wasting events.

**Table 79: West Valley Skamokawa Creek Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Eggman Cr.	1	6.7%	5	33.3%	9	60.0%	0	0.0%	15	100%
Mud Trib	2	100.0%	0	0.0%	0	0.0%	0	0.0%	2	100%
West Fork Skamokawa	0	0.0%	0	0.0%	6	40.0%	9	60.0%	15	100%
West Valley Cr.	0	0.0%	2	5.7%	21	60.0%	12	34.3%	35	100%
Total	3	26.7%	7	9.8%	36	40.0%	21	23.6%	67	100%

### *Pool Frequency*

(Appendix A Map A-16)

Table 80 and Table 81 provide data on the percentage of pool habitat gathered during Wahkiakum Conservation District stream surveys. The percentage of pool habitat in the mainstem Skamokawa Creek and the lower segments of its tributaries generally rated “poor”. This area is predominantly agriculture land use with limited riparian vegetation.

**Table 80: Middle Valley Skamokawa Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		NC		Total	
	#	%	#	%	#	%	#	%	#	%
Bell Canyon Cr.	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Falk Cr.	4	12.1%	17	51.5%	12	36.4%	0	0.0%	33	100%
Left Fork Skamokawa	0	0.0%	1	20.0%	4	80.0%	0	0.0%	5	100%
Middle Valley Skamokawa	0	0.0%	0	0.0%	5	100.0%	0	0.0%	5	100%
North F. Wilson Cr.	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Pollard Cr.	3	42.9%	4	57.1%	0	0.0%	0	0.0%	7	100%
Quarry Cr.	0	0.0%	1	25.0%	3	75.0%	0	0.0%	4	100%
Skamokawa Cr	0	0.0%	4	10.3%	35	89.7%	0	0.0%	39	100%
Standard Cr.	0	0.0%	3	42.9%	4	57.1%	0	0.0%	7	100%
Wilson Cr.	7	17.1%	2	4.9%	32	78.0%	0	0.0%	41	100%
Total	14	7.2%	32	21.2%	101	71.6%	0	0.0%	147	100%

Pool conditions improve in the upper segments of the mainstem Skamokawa and its tributaries, particularly Wilson Creek, Pollard Creek and Falk Creek. These areas are associated with forested land use where riparian vegetation and LWD also tend to improve. The TAG indicated that pool habitat in Skamokawa Creek from tidewater to the Left Fork and the lower portion of Wilson Creek would respond favorably with inputs of large woody debris.

The percentage of pool habitat rated “poor” throughout the West Fork Skamokawa with the exception of the upper one-mile that was surveyed. Eggman Creek also rated “poor” overall, with a “fair” amount of pools from RM 1.3 to 1.9.

**Table 81: West Valley Skamokawa Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		NC		Total	
	#	%	#	%	#	%	#	%	#	%
Eggman Cr.	0	0.0%	2	13.3%	13	86.7%	0	0.0%	15	100%
Mud Trib	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
West Fork Skamokawa	0	0.0%	2	13.3%	12	80.0%	1	6.7%	15	100%
West Valley Cr.	0	0.0%	4	11.4%	31	88.6%	0	0.0%	35	100%
Total	0	0.0%	8	9.5%	58	88.8%	1	1.7%	67	100%

### *Water Quality*

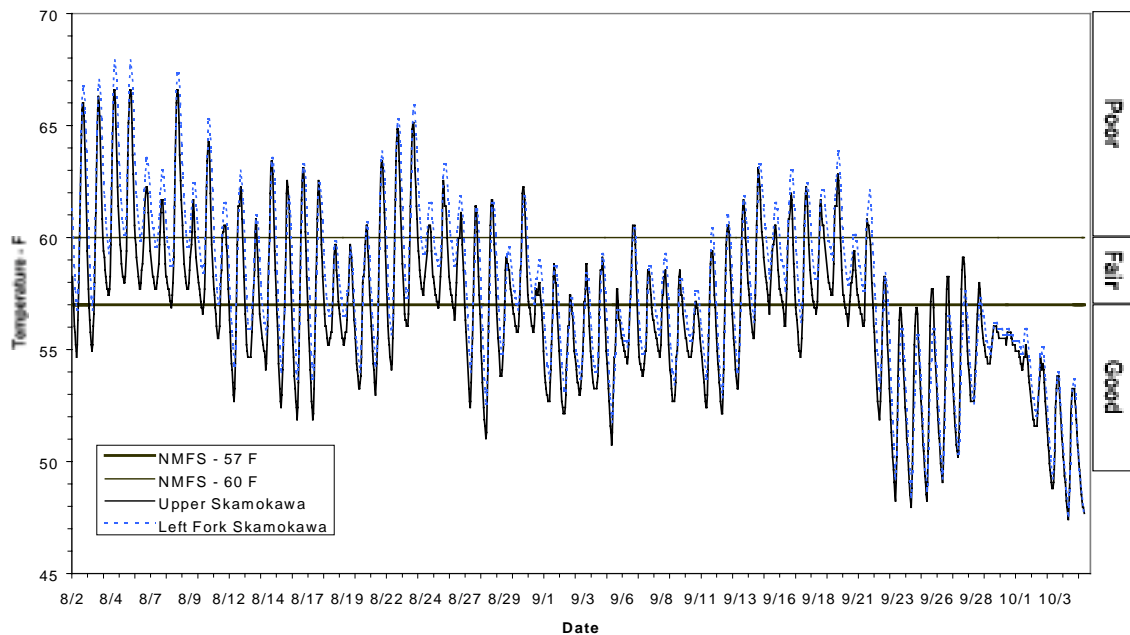
Skamokawa Creek was listed in the Department of Ecology 303d list of water-quality-limited streams for temperature, turbidity, and dissolved oxygen. The TAG thought that Left Fork Skamokawa Creek could have temperature problems in the lower reaches. Wahkiakum Conservation District began monitoring the temperature at 6 locations in the Skamokawa Creek watershed in 2000. Monitoring is planned annually through 2004.

The mainstem Skamokawa Creek was monitored at two sites. The first site was located immediately upstream of the Wilson Creek tributary (RM 2). The thermograph from this site was damaged and the data has yet to be extracted. The second mainstem site was located upstream of the Left Fork Skamokawa tributary (RM 4.5). Stream temperature was monitored in the Left Fork Skamokawa Creek just upstream from its confluence with Skamokawa Creek.

Figure 8 illustrates the temperature data obtained from these upper Skamokawa Creek sites during the summer of 2000. Washington State Conservation Commission criteria has been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning and rearing requirements for salmon (see Appendix B for more detail). Washington State’s water quality standard for Type A water is 64.4 degrees Fahrenheit. Water temperature in Skamokawa Creek exceeded 60° F during the summer months when high temperatures

can negatively impact resident fish and rearing salmonids. Elevated temperatures are likely the combined effect of a rain-dominated system, low flows, and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Some anadromous salmonids must contend with temperatures in the “fair” to “poor” range as they first enter the system.

**Figure 8: Upper Skamokawa - Year 2000 Maximum Hourly Stream Temperature**

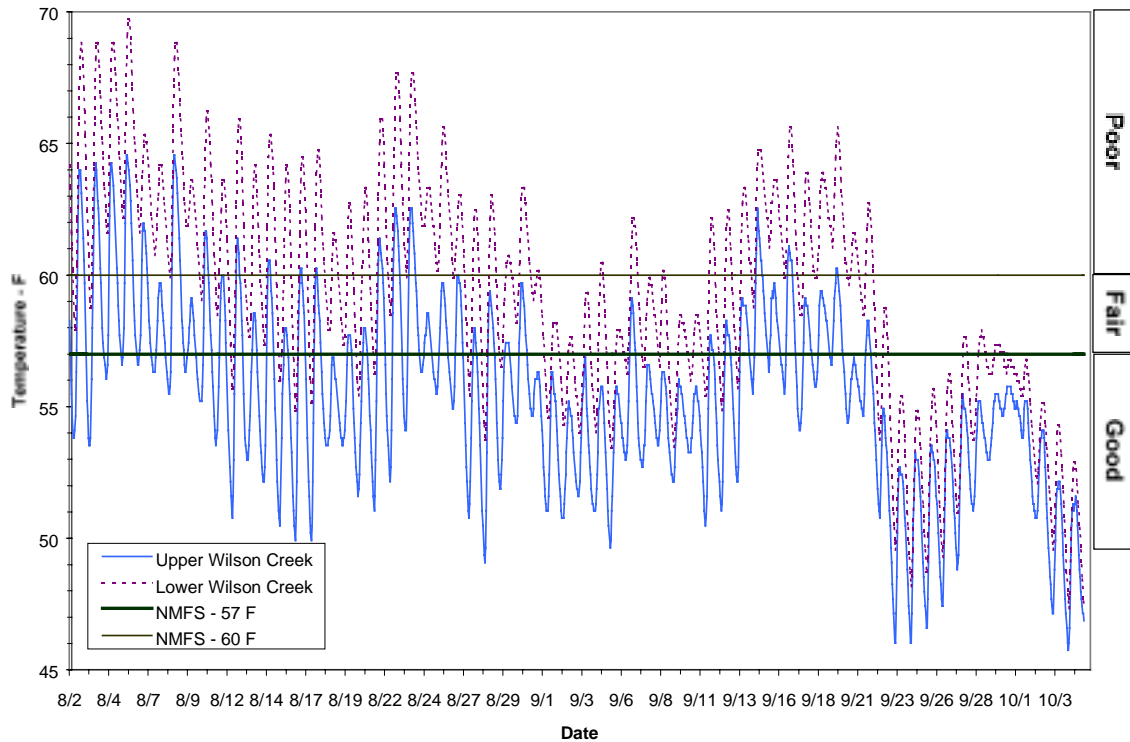


Water temperature in Wilson Creek was monitored at two sites Lower Wilson and Upper Wilson. The lower Wilson monitoring is located at the East Valley Road crossing at river mile 0.5. The upper Wilson site is located near the Department of Natural Resources park at river mile 4.5.

Figure 9 illustrates the temperature data obtained from these Wilson Creek sites during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. Water temperatures at the lower Wilson Creek site were consistently elevated through the summer months, and considerably higher than temperatures recorded at the upper monitoring site. The difference in temperatures between the two sites may reflect a lack of shade related to poor riparian conditions along the lower reaches with agricultural use. Further investigation of riparian and shade conditions is needed along these lower reaches to identify restoration projects that could help moderate water temperatures during the summer months. Stream

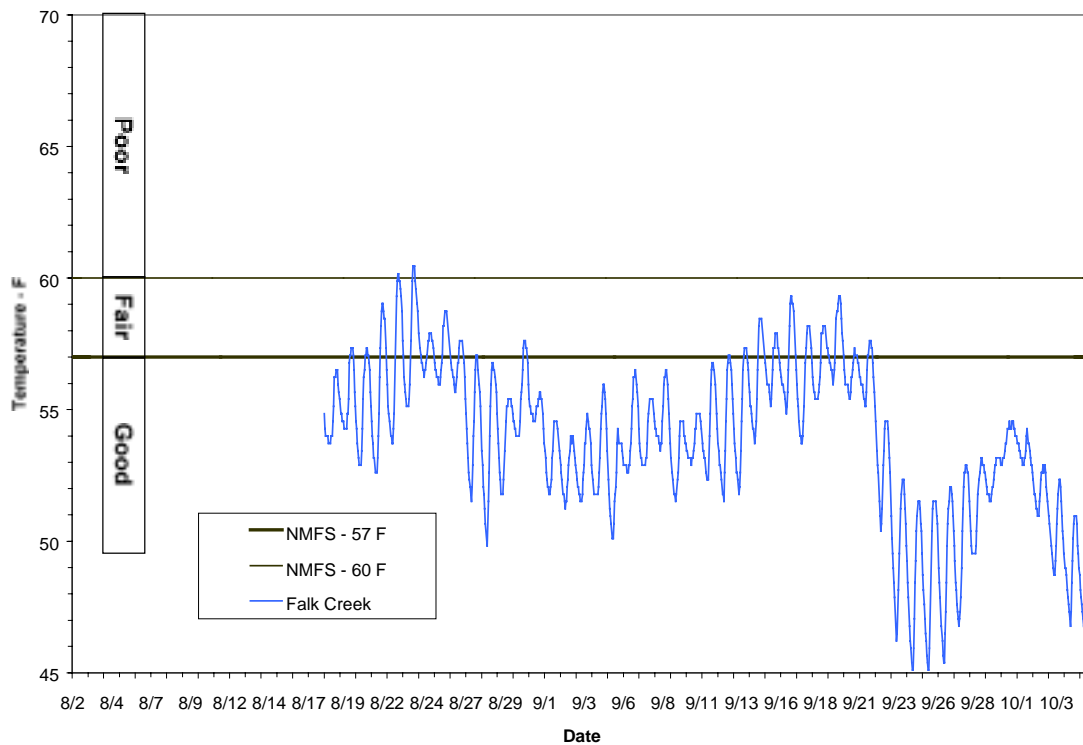
temperatures generally decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods.

**Figure 9: Wilson Creek - Year 2000 Maximum Hourly Stream Temperature**



The remaining site where water temperature monitoring occurred was in Falk Creek. This site is located immediately upstream of Falk Creek’s confluence with the Middle Valley Skamokawa Creek. Figure 10 illustrates the temperature data obtained from the Falk Creek site during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. Stream temperature in Falk Creek follows a similar pattern to other monitored sites, but temperatures remained relatively cool throughout the monitoring period. This may be indicative of watershed conditions including the presence of wetland habitat types adjacent to the creek and its flow orientation. Falk Creek flows east to west overall. Throughout most of its length it flows along the toe of hill on the south side of the valley. The hillside provides topographic shade even during summer months.

**Figure 10: Falk Creek - Year 2000 Maximum Hourly Stream Temperature**



In response to a 1975 fish kill, an assessment of water quality conditions in Skamokawa Creek was undertaken by DOE. The conclusion reached was that fecal coliform exceeded the state standard and was probably caused by human and animal sources. Further investigations identified watershed conditions and circumstances that may have contributed to the 1975 fish kill. The report from that investigation states, “It appears from a review of the available information, that the periodic fish kills have occurred in the early morning hours during periods of very low stream flow when large numbers of fish are spawning (Norton 1981).” “Aerating falls and riffles as well as attached aquatic plants are almost nonexistent in the lower reaches of the creek due to the silty bottom conditions which prevail. During the early morning hours when the dissolved oxygen concentration reaches a minimum, the added burden of several hundred fish moving upstream to spawn probably caused critical dissolved oxygen concentrations to be reached (Tracy 1975 cited in Norton 1981)”. To reduce the potential for additional fish kills the Department of Fisheries modified its management plans concerning Skamokawa Creek to allow additional fishing pressure which would reduce the number of fish

arriving upstream for spawning. The reduction in the number of spawning fish was thought to eliminate fish kills by reducing the oxygen demand from overcrowding (Fiscus, personal communication as cited in Norton 1981).”

Water quality monitoring during a wellhead protection project by Wahkiakum Conservation District (1997) determined that surface water and shallow groundwater in the Skamokawa Creek watershed had elevated fecal coliform and nitrate levels. The source of fecal coliform and nitrates was thought to be septic systems and agricultural land use.

#### *Water Quantity*

The United State Geological Survey maintained a streamflow gaging station on Skamokawa Creek near the town of Skamokawa (station #14248000). This station was operated between 1949 and 1950 (USGS, 1994).

Substantial changes from historic conditions have occurred in the land cover of the Skamokawa Watershed Administrative Unit (WAU)(same area as the Skamokawa Creek watershed). Table 82 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 82 that approximately 73.5% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. None of the watershed’s land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the watershed of greater than 3.9 miles of road/square mile also increase channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

**Table 82: Forest Seral Stage/ Land Cover in the Mitchell Creek WAU (Upper Grays)(Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
Skamokawa	Acres	0.0	10649	6980	3026	3696	27336	51687
	Percent	0.0	20.6	13.5	5.9	7.1	52.9	100.0

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities

greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

As Map A-17 illustrates, the forest cover in the Skamokawa Creek WAU is considered hydrologically immature and road densities exceed 3 miles of road/square mile, raising concerns for increased peak flows in streams in this area.

Low flows also present a problem for anadromous species that rear in freshwater over the summer months in many of the watersheds in WRIA 25. In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell, 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gaging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on Wilson Creek at the East Valley Road crossing and is presented in Table 84. Streamflow spot measurements are provided in Table 84. Data from the spot flow measurements suggests that flows in Wilson Creek were adequate to support salmon and steelhead spawning during the summer months; however flows on 11/ 9/98 were well below what most species would require for spawning.

**Table 83: Toe Width Flow for Wilson Creek**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
Wilson Creek At East Valley Road	18	49.0	24.3	49.0	44.3	9.9	8.9

Caldwell et al. 1999

**Table 84: Spot Flow Measurement for Wilson Creek**

Stream Name	Measured Flows (in cfs)		
	Date		
	9/15/98	10/13/98	11/9/98
Wilson Creek at East Valley Road	7.9	8.7	15.3

Caldwell et al. 1999

Data is lacking on low flow conditions in other streams in the Skamokawa Creek watershed; however, TAG members reported flows in Crippen Creek fall to very low levels during the dry season.

#### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

Fall chinook are the only stock in Skamokawa Creek that was considered healthy by SASSI (WDF et al. 1993), and they were likely not native to the system. Few chum salmon return to Skamokawa Creek today; however, WDF (1951) estimated that 3,000 chum spawned each year in Skamokawa Creek. WDF (1951) reported an annual escapement of 2,000 coho to this watershed. SASSI (WDF et al. 1993) considered Skamokawa Creek coho depressed based on chronically low production. Spawning escapements were not available in the SASSI report. Winter steelhead were also considered depressed (Draft LCSCI: State of Washington 1998). The escapement goal for Skamokawa Creek was 227 fish. Escapements averaged 95 percent (216 fish) of the escapement goal from 1991 to 1996 (Draft LCSCI: State of Washington 1998).

Wahkiakum County is currently studying exotic plant species (milfoil, elodea, parrot feather...) in Brooks Slough.

#### Alger Creek and Risk Creek

Stream survey data was not collected on Alger Creek or Risk Creek and TAG members had limited knowledge of conditions in this stream. Risk Creek runs through the Julia Butler Hansen Wildlife Refuge.

#### *Access*

The tide gate on Alger Creek needs to be assessed along with two culverts near State Highway #4. Columbia Land Trust was recently award project funds to mitigate

conditions on this site and improve floodplain connectivity. TAG members thought there was an impassable falls on Alger Creek at about RM 1½.

TAG members identified a pump station on the refuge that blocks approximately 1.4 miles of habitat on Risk Creek.

#### *Floodplain Connectivity*

Alger Creek is diked on its left bank for the first 1,700 feet. A project was recently awarded to Columbia Land Trust to establish a conservation easement, modify the tidegate, and improve floodplain connectivity to a significant amount of land near the mouth of Alger Creek.

#### *Side Channel Availability*

Information was not available to address side channel availability.

#### *Bank Erosion / Bank Stability*

Information was not available to address bank erosion or bank stability.

#### *Substrate Fines*

There are 9.3 total miles of roads in the subbasin; only 25 percent or 2.3 miles were active. There were twenty-one mass failures delineated on the 1986 USDA Soil Survey Maps. Most of these are in the upper reaches and on Zenker silt loam with 65-90% slopes. There is an active rock quarry in the SW ¼ of Section 14 (Waterstrat 1994).

#### *Riparian*

Stream surveys conducted by Wahkiakum County Conservation District (Waterstrat 1994) found that riparian conditions were poor in the lower reaches of the subbasin due to the lack of species variety rather than injury from livestock access. The balance of subbasin is in commercial timber ownership. It was estimated that 8 percent of the timber is 51 years or older, 59 percent is 11-50 years old, and 33 percent is 0-10 years old (Waterstrat 1994).

#### *Large Woody Debris*

Information was not available to assess LWD.

#### *Pool Frequency*

Information was not available to assess pool frequency.

#### *Water Quality*

Information was not available to assess water quality.

#### *Water Quantity*

The United State Geological Survey maintained a streamflow gaging station on Risk Creek (station #14248100). Annual peakflow data is available for 1949 and 1970

(Williams, 1985). However, that data provides little guidance on peak flow and low flow conditions.

### *Biological Processes*

Information is lacking on fish distribution and abundance in the watershed. Escapement is likely well below historic levels.

### Birnie Creek

Stream survey data was not collected on Birnie Creek and TAG members had limited knowledge of conditions in this stream. WDFW TAG members indicated that WDFW is working with the City of Cathlamet and Washington State Department of Transportation to correct fish passage at three sites in the watershed.

### *Access*

Several culvert access issues are in the process of being improved by Washington Department of Fish and Wildlife, Washington Department of Transportation, and the City of Cathlamet. One other access problem remains at the mouth of Birnie Creek where the Wahkiakum High School fish-rearing project is located. Communication with WDFW fish passage engineers (Smith 2001) indicates that projects have been completed at the Una road crossing in Cathlamet and at the culvert under State Route 4. Designs are in process that will correct passage problems associated with fish screens at the mouth of Birnie Creek.

Information is lacking on most habitat conditions, and fish distribution and utilization in Birnie Creek.

### *Riparian*

Waterstrat (1994) determined that approximately 60% of the watershed is owned by industrial timber companies; with 12% of the timber 51+ years old, 72% 11-50 years old, and 16% 0-10 years old. The remaining 40% of the watershed is in private ownership. The riparian condition in the lower reaches does not have the diversity of species found along the higher reaches where native plant cover has not been replaced or removed (Waterstrat 1994).

There are 7.61 miles of road within the watershed, 33 percent of which are in active use. Only one slide was noted on Cathlamet silt loam with a slope of 8-30 percent in the 1986 USDA Soil survey Map and is (Waterstrat 1994).

### *Biological Processes*

Data on historic and recent escapements is lacking in the Birnie Creek watershed. Wahkiakum High School (WHS) in cooperation with Washington State Department of Fish and Wildlife is currently managing a coho rearing pond at the mouth of Birnie Creek.

## Elochoman River

### *Access*

(Appendix A, Map A3)

Several fish passage problems have been identified for the Elochoman River watershed. The following list includes access problems identified through stream surveys, culvert surveys, and the TAG.

- The hatchery intake on the Elochoman near Beaver Creek may limit passage and it needs assessment.
- Nelson Creek, at RM 2.0, has culvert with a three- percent gradient.
- An unnamed tributary to Nelson Creek at RM 0.1 has a culvert with a steep gradient.
- An unnamed tributary #2 to Nelson Creek at RM 0.1 has a plugged culvert that has caused stream to reroute across road.
- Although the Beaver Creek Hatchery is no longer in operation, RM 5, the water intake dam may be a barrier and needs assessment.
- Beaver Creek Falls, RM 2.2 – 2.5, is series of falls/cascades and logjams that may block fish passage.
- Duck Creek has four culverts between RM 0.1 to 1.7 with outfalls and steep gradients.
- Clear Creek at RM 9 has a culvert and the hatchery's water intake that may be passage barriers and need assessment.
- Rock Creek, RM 11, has culverts under the old railroad grade and county road that need assessment.
- Rock Creek, RM 1.0, has a logging road culvert that failed in December 1998. The forest landowner is in the process of replacing the culvert.
- An unnamed tributary to North Fork Elochoman has a 120-foot long culvert with a four- percent gradient and a five-foot outfall.
- Otter Creek, an East Fork Elochoman River tributary, has a 15-foot falls at RM 1.0.
- TAG members identified potential passage problems with a county culvert and a state culvert on Beavalo Creek.

The quality and quantity of habitat available about these blockages should be evaluated along with standardized barrier assessments.

### *Floodplain Connectivity*

The Elochoman River floodplain is diked on the right bank from the mouth to Nelson Creek (RM 1.4). This reach of the Elochoman River parallels the Julia Butler Hansen Wildlife Refuge. Steamboat Slough Road is on the top of this dike. Nelson Creek is diked along the right bank from its mouth to Risk Road (RM 0 to RM 1.0). Nelson Creek is also channelized in the agricultural areas (RM 0 to 2.5).

The Elochoman mainstem has stream-adjacent roads in many locations throughout the valley. An old railroad grade, RM 9 to RM 16, was built along the river. This railroad grade may prevent side-channel formation in the area downstream of the gorge. Beaver Creek has a stream-adjacent road along its right bank for approximately one-half of its length. Beaver Creek Road keeps the creek confined between the road and the hillside.

Floodplain connectivity is reduced along most of the length of the North Fork Elochoman by a stream-adjacent road on its left bank. Although specific data regarding stream entrenchment was not collected during stream surveys, general observations by the TAG indicate that Elochoman River is highly entrenched through reaches of agriculture land use. Floodplain connectivity tends to improve in the upper watershed.

The effects of splash damming (entrenchment, lack of LWD) are still evident in the middle portion of the Elochoman River. Splash dams consisted of temporary dams that created a backwater pond. Logs were dumped into the pond and the channel below it. Once filled with logs and water, the dam was breached and a torrent of logs and water was released. The process was then repeated.

#### *Side Channel Availability*

From State Route 4 to Beaver Creek, the mainstem Elochoman River is highly entrenched, limiting side channel development. Survey notes indicate some side channel habitat in a 4,000-foot reach immediately downstream of Beaver Creek. Just downstream and just upstream of the Beaver Creek Hatchery side channel habitat exists but it has been largely disconnected from the river due to channel incision. From Beaver Creek to the West Fork (RM 5.5 to RM 15.9) the road and hillside confine the river. This reach is highly entrenched further limiting the development of side channels.

The West Fork Elochoman stream has many side channels and small scour pools. In addition there were some large pools with extensive cove habitat associated with logjams in the main channel. These logjams were anchored by old growth LWD with recently recruited alder LWD contributing to these formations (WDNR 1996).

Agricultural activities have limited side-channel development in Nelson Creek. Stream survey notes indicate the presence of side channels in the middle segments of Beaver Creek, RM 1.4 to RM 1.8. These appear to be associated with the presence of logjams and the resulting accumulation of bedload (WCD 2001). Surveyors indicated that these side channels were of low quality and appeared transient. TAG members noted that the confinement between the hillside and road limits the stream's ability to develop side channels, especially through the 1.5-mile long canyon.

One good side channel area was noted in the lower 2,000 feet of the West Fork Elochoman. An occasional side channel was noted in the upper segments of the mainstem Elochoman. Side channel availability in the North Fork Elochoman is limited because of the stream-adjacent road from the mouth to the major forks, RM 19. The road has been washed out several times.

*Bank Erosion / Bank Stability*  
(Appendix A, Map A12)

Wahkiakum County Conservation District stream surveys determined that bank erosion generally rated “good” in the Elochoman watershed (see Table 85). However, TAG members were concerned that this data did not accurately reflect problems associated with mass wasting in the subbasin, which they considered extensive. Mass wasting and erosion conditions need additional assessment in the subbasin to determine the extent of the problem. Riprap has been installed in several locations along the mainstem Elochoman River. Stream surveyors gave a “good” erosion rating to the mainstem Elochoman River, but did note occasional erosion concerns primarily associated with the road.

The diked and channeled sections of Nelson Creek were generally stable. At approximately RM 2 the stream is allowed to naturally meander. Bank erosion rating declines to “fair” or “poor” due to erosion that was observed on outside meander bends through agricultural areas. TAG members indicated that a tributary to Nelson Creek has significant bank erosion problems. There are numerous beaver dams along Nelson Creek, which cause the creek to migrate outside its channel (TAG).

**Table 85: Elochoman River Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Beaver Creek	16	100.0%	0	0.0%	0	0.0%	0	0.0%	16	100%
Beaver Cr. Trib.	4	100.0%	0	0.0%	0	0.0%	0	0.0%	4	100%
Duck Cr.	13	100.0%	0	0.0%	0	0.0%	0	0.0%	13	100%
Elochoman River	111	98.2%	1	0.9%	0	0.0%	1	0.9%	113	100%
Nelson Cr.	16	80.0%	2	10.0%	2	10.0%	0	0.0%	20	100%
North Fork Elochoman	29	100.0%	0	0.0%	0	0.0%	0	0.0%	29	100%
Otter Creek	2	100.0%	0	0.0%	0	0.0%	0	0.0%	2	100%
West Fork Elochoman	28	100.0%	0	0.0%	0	0.0%	0	0.0%	28	100%
Total	219	97.3%	3	1.4%	2	1.3%	1	0.1%	225	100%

The TAG noted that the West Fork Elochoman has mass wasting and bank stability problems along most of its length. Mass wasting occurrences in the watershed are often associated with roads (TAG). Stream surveys were conducted on 21,000 feet of the West Fork Elochoman River. Bank erosion rated “good” throughout the surveyed segments. However, survey notes indicated a decline in fish habitat starting 17,000 feet upstream because the streambed appears to have been re-graded by mass wasting.

The TAG noted that the North Fork Elochoman has bank stability problems due to mass wasting and numerous debris flows. Stream surveys on the lower three miles did not identify any significant areas with streambank erosion. Four types of mass wasting features are identified in the North Elochoman watershed. In order of abundance they are

shallow-rapid landslides, large deep-seated landslides and earthflows that persist in the landscape for hundreds of years, debris torrents, and small, deep-seated failures that are sporadic in the landscape through time. Out of 383 landslides in the basin, 178 (46%), occurred naturally, without human contribution. Natural landslides consisted of 138 large persistent deep-seated failures, 28 small sporadic deep-seated failures, 8 shallow-rapid slides, and 4 debris torrents. In comparison, the remaining 54% of the mass wasting events were associated with forest practices (205 landslides and 57 debris torrents), indicating that forest practices have had marked effects on the landscape (DNR 1996).

### *Substrate Fines*

(Appendix A, A13)

Table 86 provides data from Wahkiakum County Conservation District stream surveys on fine sediment conditions in the Elochoman River watershed. Substrate fines accumulated in the mainstem Elochoman throughout the tidally influenced area. From the tidewater to Duck Creek, the mainstem rated “good” for substrate fines. All surveyed reaches of Nelson Creek (20 - 1000-foot reaches) rated “poor” for substrate fines (see Table 86). However, gravel content does begin to increase with increasing stream gradient. Beaver Creek rated “good” for substrate fines in 15 of 16 surveyed reaches. Approximately half of the surveyed reaches of Duck Creek rated “poor” for fine substrates and half rated “good”. Rock Creek had excessive fines that were associated with a recently failed road culvert.

Sediment ratings are highly variable for the mainstem Elochoman from Duck Creek upstream. From the hatchery to the West Fork confluence (RM 5.5 to 15.9), the mainstem consists of approximately 18% silt and 27% sand. This excessive fine sediment load may be associated with mass wasting and bank stability problems in the West Fork Elochoman River. Upstream of the West Fork confluence, the mainstem Elochoman and its tributaries exhibited a better mix of spawning gravels.

The West Fork Elochoman and North Fork Elochoman rated generally “poor” for substrate fines. These ratings tend to support TAG concerns with mass wasting in the upper Elochoman River watershed. TAG members reported that fine sediments were not as large of a problem in the North Fork Elochoman watershed as in the West Fork Elochoman. However, that is inconsistent with the results of the stream survey in which found only 15 of 28 reaches in “poor” condition in the West Fork compared to 21 of 29 reaches in the North Fork.

A Washington Department of Natural Resources Watershed Analysis of the North Fork Elochoman (WDNR 1996) found that fish habitat in the mainstem of the North Fork Elochoman (and all channels of similar geomorphic type) was characterized as having generally good spawning gravel, rearing pools, adult holding pools and in-channel LWD. Side-channel habitat and cover were considered in fair condition. However, the fine sediment content rated poor. Fine sediment was routinely visible in the inter-gravel spaces and sometimes accumulated on the surface of spawning riffles. On November 22,

1994, 3 days after a moderate storm that should have flushed some of the fines out of the gravel, fines had already filled inter-gravel spaces and sand streaks were evident on the surface of some spawning riffles in the upper part of the mainstem. Fine sediment appears to be a problem throughout the watershed (WDNR 1996)

Most of the rock formations in the North Fork Elochoman watershed are weak and tend to decay into predominantly fines. Shallow rapid landslides from steep slopes in all areas of the watershed have delivered excessive fine sediments to the stream channel. Most historic shallow rapid landslides were attributable to forest practices. Road erosion and surface erosion associated with forest practices might have a significant impact on the level of fine sediments in a few stream channels. However, on a watershed scale, these sources have an insignificant contribution above background levels (WDNR 1996).

Erosion from logging activities within areas of high to moderate erosion potential shows very little evidence of sediment delivery. This is partly due to logging practices designed to eliminate or reduce soil disturbance. Leftover slash cover, rapid revegetation, and high permeability of soils also reduce soil erosion. Delivery of sediment to streams by roads is the dominant delivery mechanism. There are numerous stream crossings and roads within 200 feet (stream adjacent roads) of a typed stream channel in the North Fork Elochoman watershed. New roads (less than two years old) and those adjacent to streams are contributing the most sediment. The WDNR North Elochoman Watershed Analysis (1996) recommends a road inventory and a plan implemented to correct surface erosion problems. Industry TAG members confirmed that road plans are underway.

**Table 86: Elochoman River Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Beaver Creek	15	93.8%	1	6.3%	0	0.0%	0	0.0%	16	100%
Beaver Cr. Trib.	4	100.0%	0	0.0%	0	0.0%	0	0.0%	4	100%
Duck Cr.	6	46.2%	1	7.7%	6	46.2%	0	0.0%	13	100%
Elochoman River	38	33.6%	28	24.8%	47	41.6%	0	0.0%	113	100%
Nelson Cr.	0	0.0%	0	0.0%	20	100.0%	0	0.0%	20	100%
North Fork Elochoman	2	6.9%	6	20.7%	21	72.4%	0	0.0%	29	100%
Otter Creek	2	100.0%	0	0.0%	0	0.0%	0	0.0%	2	100%
West Fork Elochoman	5	17.9%	8	28.6%	15	53.6%	0	0.0%	28	100%
Total	72	49.8%	44	11.0%	109	39.2%	0	0.0%	225	100%

The East Fork Elochoman had very little sand and no silt, and above Otter Creek it had up to 72 percent bedrock. Road densities in the East Fork are low (WCD 2001).

Waterstrat (1994) determined that there are approximately 260 miles of roads making a density of 3.94 miles of road/square mile within the Elochoman River Watershed. Approximately 32 percent of the roads are considered actively used. Road densities

above 3.0 miles/square mile likely contribute excessive fine sediments to stream channels (see Appendix B). There were also 173 mass failures noted on the 1986 USDA Soil Survey Maps. Most of these are found on Katula silt loam with slopes of 30-65 percent and 65-90 percent, and Lytell silt loam with slopes of 30-65 percent. This makes an average density of mass failures throughout the subbasin of 2.62 failures/square mile (Waterstrat 1994).

Within the Nelson Creek watershed, there are approximately 16 miles of road with approximately 6 percent active. Eleven mass failures were noted on the 1986 Soil Survey Maps; these were primarily on Zenker silt loam with 65-90 percent slope. The overall density of mass failures is 2.87 failures/square mile. There is a slip about 16" deep which crosses a spur road in the upper reaches of the watershed (Waterstrat 1994).

### *Riparian*

(Appendix A, Map A14)

Most of the timber in the Elochoman watershed was harvested in 1953 (TAG). Road construction and harvest techniques at that time seriously impacted riparian function. The basin has regrown a new crop of harvestable trees and the riparian corridors are gradually improving. However, the current riparian material is mostly deciduous and, as such, will not replace the long-term, key-piece LWD that is disappearing. The most apparent concerns are as follows:

- A high concentration of deciduous trees are shading out conifers;
- Old slide and new mass wasting areas continue to impact riparian functions;
- And, stream-channel widening caused by soil and debris flows has reduced riparian cover especially at side channel junctions. (WDNR 1996).

Over 72% of the surveyed reaches in the Elochoman River subbasin rated "poor" for riparian conditions (see Table 87). The lower reaches of the mainstem Elochoman and Nelson Creek have "poor" riparian conditions due to agricultural clearing and dike construction (WCD 2001). Narrow buffer widths and the lack of coniferous species reduce riparian function in these segments. Between the hatchery and the West Fork confluence (RM 5.5 to 15.9) riparian corridors have fairly mature trees but they are mainly deciduous species. A county road and old railroad grade influence riparian buffer width along this reach. The percentage of conifers increases in the upper segments of the West Fork but the age class tends to decrease.

The forested tributaries, Beaver Creek and Duck Creek, had a number of reaches with "fair" and even "good" riparian conditions (see Table 87). Their riparian corridors generally contain a good mix of coniferous and deciduous species. Relatively immature trees or narrow buffer widths prevented a "good" rating along these tributaries. The County road limits the function and further development of riparian vegetation along the lower segments of Beaver Creek.

Riparian conditions along the lower three miles of the West Fork Elochoman rated “poor” because of the predominance of immature deciduous species. The upper mile rated “fair” as the percentage of conifer species and the age class increased. The area has been heavily logged and has a high road density (TAG).

**Table 87: Elochoman River Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Beaver Creek	0	0.0%	6	37.5%	10	62.5%	0	0.0%	16	100%
Beaver Cr. Trib	0	0.0%	3	75.0%	1	25.0%	0	0.0%	4	100%
Duck Cr.	2	15.4%	2	15.4%	9	69.2%	0	0.0%	13	100%
Elochoman River	0	0.0%	20	17.7%	93	82.3%	0	0.0%	113	100%
Nelson Cr.	0	0.0%	2	10.0%	18	90.0%	0	0.0%	20	100%
North Fork Elochoman	0	0.0%	11	37.9%	18	62.1%	0	0.0%	29	100%
Otter Creek	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
West Fork Elochoman	0	0.0%	3	10.7%	25	89.3%	0	0.0%	28	100%
Total	2	1.9%	47	25.5%	176	72.5%	0	0.0%	225	100%

Riparian conditions rated “poor” in the mainstem Elochoman above the West Fork confluence and its tributaries. Buffer widths and species composition were highly variable, while age classes were relatively young. The stream-adjacent railroad grade and roads limit the development of functional riparian corridors in the upper Elochoman mainstem.

In 1949, Bryant reported that, “The West Fork watershed is completely logged off and burned, and the stream has been considerably damaged by the resulting erosion and silting.” Only a small part of the stream will be suitable for spawning until the watershed regains its forest cover and the former suitable stream conditions are re-established (Bryant 1949). These operations were being extended to the remainder of the watershed and would continue to cause silting and erosion for many years (Bryant 1949).

Approximately 95.5 percent of the watershed is either privately owned or state land managed; 48 percent has 50+ years old timber, 42 percent is 11-50 years old, and 10 percent is 0-10 years old. The remaining 4.5 percent of land is in agriculture and/or residential uses. Based on counts, animal density was estimated to be .17 animals/acre. Riparian condition was judged to be good along 60 percent of the stream banks with animals having access to approximately fifty three percent of the stream length in the agricultural reaches (Waterstrat 1994).

Approximately 97 percent of the Nelson Creek subbasin is privately owned industrial forest lands; 9 percent has 50+ years old timber, 62 percent is 11-50 years old, and 29 percent is 0-10 years old. The remaining 3 percent is used for agricultural and/or

residential purposes. Based on field observation, the density of farm animals is estimated to be 0.98 animals/acre. The riparian condition was noted as good along only thirty percent of the stream banks (Waterstrat 1994).

### *Large Woody Debris*

(Appendix A, Map A15)

Table 88 provides data from Wahkiakum County Conservation District stream surveys. Over 83% of the surveyed stream segments had “poor” levels of LWD in the Elochoman watershed. LWD was non-existent in many of the surveyed segments in the lower river. Single logs functioning in the river are rare. Most of the LWD was observed in logjams, which contained both deciduous and conifer wood. Nelson Creek had numerous logjams of deciduous wood throughout its length. One logjam was 28- by 24-feet long. The segments that rated “fair” are typically the uppermost reaches of tributary streams. These segments averaged less than 15-feet wide to ordinary high water.

The number of key pieces of LWD in the Elochoman watershed is deteriorating. Key pieces are primarily large conifer that entered the riparian system either during the last harvest or as a result of mass wasting events (WCD 2001).

The Elochoman River, from the Elochoman Salmon Hatchery to the West Fork Elochoman (RM 5.5 to 15.9), had a minimal amount of LWD identified during the stream survey. Any logjams that occur are quickly moved downstream because of the high gradient.

**Table 88: Elochoman River Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Beaver Creek	1	6.3%	1	6.3%	9	56.3%	5	31.3%	16	100%
Beaver Cr. Trib	0	0.0%	0	0.0%	4	100.0%	0	0.0%	4	100%
Duck Cr.	0	0.0%	1	7.7%	11	84.6%	1	7.7%	13	100%
Elochoman River	0	0.0%	1	0.9%	102	90.3%	10	8.8%	113	100%
Nelson Cr.	0	0.0%	5	25.0%	13	65.0%	2	10.0%	20	100%
North Fork Elochoman	0	0.0%	3	10.3%	24	82.8%	2	6.9%	29	100%
Otter Creek	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	100%
West Fork Elochoman	0	0.0%	0	0.0%	27	96.4%	1	3.6%	28	100%
Total	1	0.8%	11	6.3%	192	84.4%	21	8.5%	225	100%

The West Fork Elochoman has a number of segments with broad flat valley floors ranging from 100 to 500 feet wide. The sides of these valleys are typically forested (mixed alder and conifer) and quite steep. Bedrock exposures are not apparent. In addition there were some large pools with extensive cove habitat associated with logjams

in the main channel. These logjams were anchored by old growth LWD with recently recruited alder LWD contributing to these formations (WDNR 1996).

#### *Percent Pool*

(Appendix A, Map A16)

Table 89 provides data from Wahkiakum County Conservation District stream surveys in the Elochoman River watershed. Over 84% of the surveyed reaches rated “poor” for percent pools. Streams in the upper areas of this system had a higher percentage of pools than streams in the lower reaches (WCCD 2001). In Nelson Creek and Beaver Creek, the presence of pools appears to correspond with areas where LWD is accumulating in jams (WCD 2001). Channel processes create most of the pools in the mainstem Elochoman from the salmon hatchery to West Fork Elochoman, RM 5.5 to 15.9 (TAG). Most of the smaller tributaries had more pools than the main forks of the Elochoman (WCD 2001).

The West Fork Elochoman stream has many side channels and small scour pools. In addition there were some large pools with extensive cove habitat associated with logjams in the main channel. These logjams were anchored by old growth LWD with recently recruited alder LWD contributing to these formations (WDNR 1996).

**Table 89: Elochoman River Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Beaver Creek	0	0.0%	7	43.8%	9	56.3%	0	0.0%	16	100%
Beaver Cr. Trib	0	0.0%	0	0.0%	4	100.0%	0	0.0%	4	100%
Duck Cr.	1	7.7%	2	15.4%	10	76.9%	0	0.0%	13	100%
Elochoman River	1	0.9%	8	7.1%	104	92.0%	0	0.0%	113	100%
Nelson Cr.	1	5.0%	4	20.0%	15	75.0%	0	0.0%	20	100%
North Fork Elochoman	0	0.0%	0	0.0%	29	100.0%	0	0.0%	29	100%
Otter Creek	0	0.0%	1	50.0%	1	50.0%	0	0.0%	2	100%
West Fork Elochoman	0	0.0%	1	3.6%	26	92.9%	1	3.6%	28	100%
Total	3	1.7%	23	17.5%	198	80.4%	1	0.4%	225	100%

#### *Water Quality*

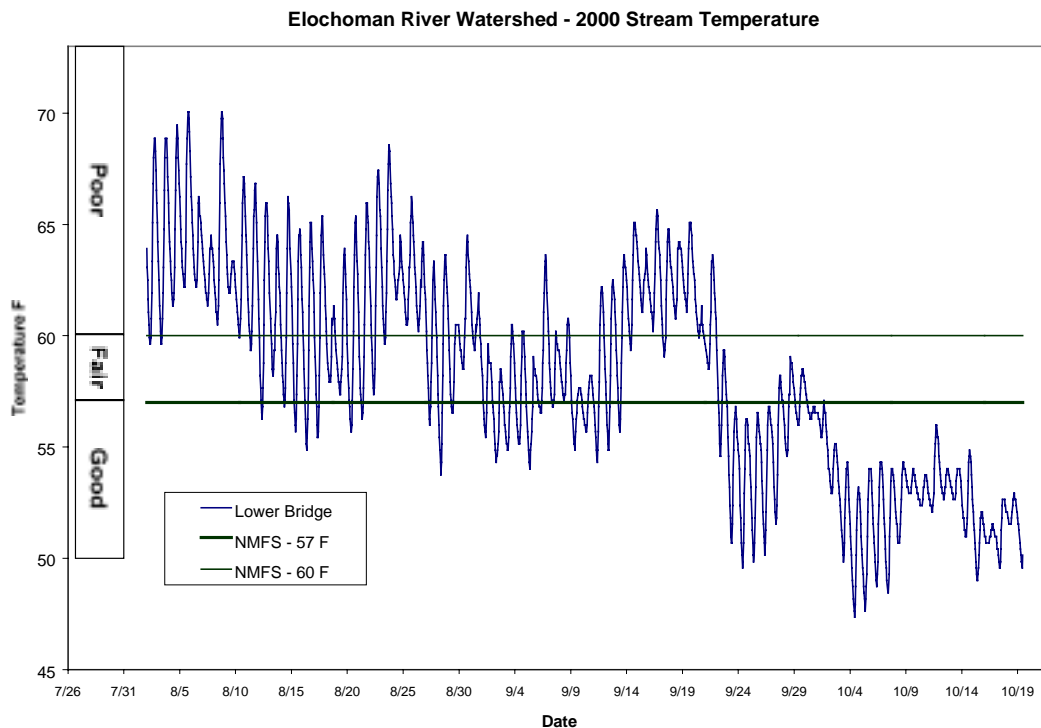
Low flows heat the Elochoman River from the hatchery to the West Fork confluence (RM 5.5 to 15.9)(TAG). WDFW temperature data for the Beaver Creek and Elochoman Hatcheries is available. The Washington Department of Fish and Wildlife has recorded numerous excursions beyond the temperature criteria at the Elochoman Hatchery (WDOE 1998). Washington State Department of Ecology maintained an ambient monitoring site (Station #25C070 @ river mile 5) at the same location (first bridge downstream of Beaver Creek hatchery). The majority of the data available was collected during the mid-1970's. Some of the specific parameters that DOE monitored include: flow, temperature,

specific conductivity, dissolved oxygen, nitrogen, phosphorous, pH, and suspended solids (WDOE 2000). This location was also the site of a USGS gaging station. These data sources provided the basis for listing the Elochoman River on the Department of Ecology's list of water quality impaired streams (303d list).

Wahkiakum Conservation District began monitoring stream temperature at 5 locations in the Elochoman watershed in 2000. Monitoring is planned annually through 2004.

Figure 11 illustrates the temperature data obtained from the mainstem Elochoman during the summer of 2000. The site is located upstream of the first bridge crossing downstream of the Beaver Creek hatchery. Washington State Conservation Commission criteria has been applied to the figure as two horizontal lines. Washington State water quality standard for type A water is 64.4° Fahrenheit.

**Figure 11: Lower Elochoman - Year 2000 Maximum Hourly Stream Temperature**

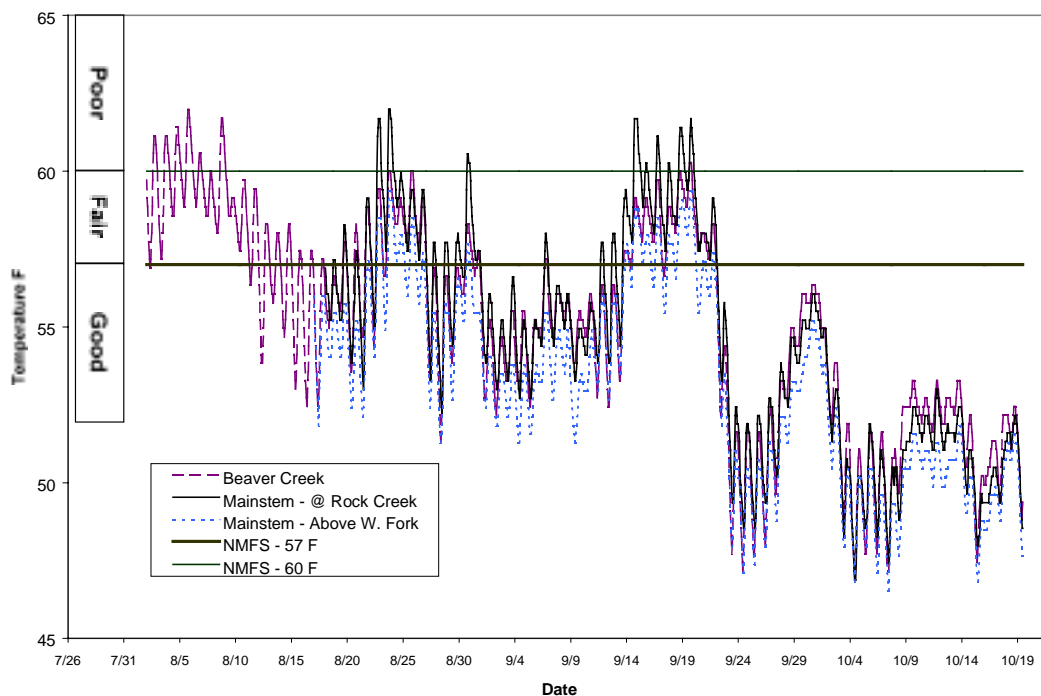


Stream water temperatures increase during the summer months when it can become a concern for resident fish and rearing salmonids. Figure 11 shows that there were a few days in August of 2000 when stream temperatures exceeded 70° F, and that there were several periods in August and September where even minimum stream temperatures exceeded 60° F. Elevated water temperature can represent a combined effect of a rain-dominated system, low flows, hydro-modification and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods.

Coho may contend with temperatures in the “fair” to “poor” range as they first enter the system in the fall.

Figure 12 illustrates the data collected from upper mainstem sites and the Beaver Creek tributary. The data follows the same trend, as that for the lower mainstem site except stream temperature is typically cooler. This indicates that riparian condition and possibly hydro-modifications may effect the lower Elochoman.

**Figure 12: Upper Elochoman and Tributaries - Year 2000 Hourly Maximum Stream Temperature**



### *Water Quantity*

United State Geological Survey maintained a streamflow gaging station on the Elochoman River at river mile 5 (Station #14257500). The Elochoman River station was operated through a period from 1941 through 1971. This location is the same one used for WDOE’s ambient monitoring station and the Wahkiakum Conservation District temperature-monitoring site.

Substantial changes from historic conditions have occurred in the land cover of the Main and North Elochoman Watershed Administrative Units (WAU)(same area as the Elochoman River watershed). Table 90 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 90 that approximately

63.9% of the land cover in the Main Elochoman WAU and 52.5% of the land cover in the North Elochoman WAU is now in early seral stages, non-forest, and other land covers. None of the watershed's land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the Main Elochoman WAU exceed 4.0 miles of road/square mile which also increases channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991). Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water).

Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0. As Map A-17 illustrates, the forest cover in the both the Main Elochoman and North Elochoman WAUs were considered hydrologically immature. Road densities exceed 3 miles of road/square mile in the Main Elochoman WAU but not in the North Elochoman WAU.

**Table 90: Forest Seral Stage/ Land Cover in the Main and North Elochoman WAUs (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
<b>Main Elochoman</b>	<b>Acres</b>	0	9430	3580	5095	8320	13779	40203
	<b>Percent</b>	0.0	23.5	8.9	12.7	20.7	34.3	100.0
<b>North Elochoman</b>	<b>Acres</b>	0	11198	5017	0.0	0.0	7281	23496
	<b>Percent</b>	0.00	47.7	21.3	0.0	0.0	31.0	100.0

Data from Lunetta et al. 1997

The Department of Ecology (Sinclair and Pitz 1999) used gauging station data to estimate the contribution of baseflow (groundwater) to total streamflow during summer low-flow periods to evaluate the interrelationship between groundwater and streamflow. In the Elochoman River watershed, 90% of the total streamflow during the month of July is contributed by baseflow. This indicates significant connectivity between groundwater and surface water in this watershed.

The mainstem Elochoman from the hatchery to the West Fork Elochoman River (RM 5.5 to 15.9) has both low and high flow problems (TAG). High entrenchment contains all of

the energy within the active channel. USGS stream gauging station data is available at RM 5.0 from 1941-71.

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell, 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gaging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on the Elochoman River at the steel bridge crossing and is presented in Table 91. Streamflow spot measurements are provided in Table 92.

In the Elochoman River, October through November median flows ranged from 50 to 700 c.f.s. Optimal flows for spawning during this period are 350 c.f.s. Consequently, by the first of November near optimal spawning conditions were reached. Steelhead spawning conditions are near optimal in March and April, being sub-optimal in May when median flows drop below 200 c.f.s. By July median flows in the Elochoman dip below 40 c.f.s., which is less than 50% of optimal flows for steelhead and salmonid spawning and rearing (Loranger 2000).

**Table 91: Toe Width Flows for Elochoman River**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Reaing
Elochoman River at the Steel Bridge	89	355.5	196.8	355.5	282.9	96.2	89.2

Caldwell et al, 1999

**Table 92: Spot Flow Measurements for the Elochoman River**

Stream Name	Measured Flows (in cfs)							
	Date							
	10/1/97	11/1/97	12/1/97	1/1/98	3/1/98	6/1/98	7/1/98	8/1/98
Elochoman River at the Steel Bridge Crossing	141.1	694.1	503.3			91.7	45	

Caldwell et al, 1999

The City of Cathlamet withdraws water from the Elochoman River for its domestic supply. According to Gibbs and Olson, Inc. (2000), the Cathlamet Regional Water System serves 1,031 connections. The system relies on the Elochoman River for 100% of their water supply. The intake is located approximately 2 miles east of State Route 4 along State Route 407 (RM 4) and consists of an intake pipe located two to four feet below the river bed. The system currently monitors source water for fecal coliform once per month and is measuring turbidity continuously.

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993). In their 1951 report, WDF estimated annual chum escapement to the Elochoman River at 1,000 fish. Very few chum have returned to the Elochoman over the last few years, and they are not now considered a separate stock by WDFW. Natural spawning of coho in the Elochoman is presumed (through unpublished information) to be quite low, and subsequent production is below stream potential (WDF et al. 1993). This stock was considered depressed, based on chronically low production. Elochoman River winter steelhead were also considered to be depressed, based on chronically low production. The escapement goal for the Elochoman River is 626 fish. Escapements have averaged 38 percent (237 fish) of the escapement goal from 1991 to 1996 (Draft LCSCI: State of Washington 1998).

### **Mill/Abernathy/Germany Creek Subbasin**

The Mill-Germany subbasin has been broken down into 5 principal watersheds to assist in discussions with the TAG, and for presentation of the available data.

- **Mill Creek** (Mill Creek, and South Fork Mill Creek)
- **Abernathy Creek** (Cameron, Slide, Weist, Midway, Erick, and Ordway Creeks)
- **Germany Creek**
- **Coal Creek** (Mosquito and Clark Creeks)
- **Longview Ditches**

### Mill Creek (Mill Creek, and South Fork Mill Creek)

Stream surveys have only been conducted on approximately 8 miles of the mainstem Mill Creek. Cowlitz and Wahkiakum Conservation Districts intend to complete survey work in the watershed in the near future.

#### *Access*

(Appendix A, Map A-4)

One culvert, located on an unnamed tributary to Mill Creek, is the only known barrier in the watershed.

The effects of splash damming are still evident in the lower mile and a half of Mill Creek. Approximately 1.5 miles of the Mill Creek channel bears the signature of splash damming. The channel is scoured to bedrock due to major incision, and the channel cross sections in several areas are best described as an open-top pipe. Although no supporting information was located, it appears that fish passage has been a concern throughout the bedrock portions of the channel. Stream surveys identified several sites where it appears that chutes were blasted into the bedrock and sites where reinforcement bar and cable anchors may have once served as anchors in a wood placement project. During stream surveys, several residents indicated that fall chinook enter the stream in early fall (September) when flows are low enough that they need to help fish migrate upstream by hand clearing a thalweg between pools.

TAG members thought that channel conditions at the mouth of Spruce Creek may limit fish passage into Spruce Creek. Stream surveys indicated that this channel is developing into step pool morphology and that the passage issues may be naturally resolved.

#### *Floodplain Connectivity*

(Appendix A, Map A11)

The first 2,000 feet of Mill Creek is tidally influenced, yet is considered incised. Mill Creek Road serves to confine this stretch of creek; helping to maintain incised conditions. Floodplain connectivity throughout lower Mill Creek has been impaired by past practices. Splash damming has resulted in an incised channel throughout the lower 1.5 miles. Extreme flood events are contained within the channel. Tributaries to this portion of Mill Creek have been affected by channel incision in the mainstem.

The South Fork Mill Creek is moderately entrenched through the first 3,000 feet. Exposed bedrock is evident through most of this reach; however, the stream is showing signs of recovery. Large rock mobilized by the stream is collecting to form steps in the lower 1,000 feet. These steps along with limited pieces of LWD are beginning to trap cobble and gravel resulting in localized aggradation of the streambed.

Although surveys have not been completed in the upper watershed, floodplain connectivity appears to improve. From RM 2 to 10, the stream varies from good connectivity to slightly entrenched (WCD 2001). From RM 10 to the headwaters, topographic maps and aerial photographs indicate that the stream flows through a series of wetlands.

Table 93 provides data from Cowlitz Conservation District on valley bottom width and ordinary high water width measurements at 200-foot intervals within each 1,000-foot survey segment. Entrenchment ratios (valley bottom width/ordinary high water width) were calculated for the 200-foot observations then averaged to obtain an estimate for the entire stream segment. Rosgen (1996) entrenchment values, as adapted from the NRCS Stream Restoration Handbook, were used to apply a Good, Fair, Poor rating to each reach. The rating used was:

Good	Fair	Poor
$\geq 2.2$ width to depth ratio	$>1.4$ and $<2.2$ width/depth	$<1=1.4$

The ratings were applied to all stream segments. Information was not available to discern channel types or channel confinement. In the lower watersheds (unconfined channel types) the ratings provide an indication of entrenchment. For segments in the upper watershed (confined channel types) the values represent more of a level of confinement.

**Table 93: Mill Creek Fine Entrenchment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	29	76.3%	6	15.8%	3	7.9%	0	0.0%	38	100%
Total	29	76.3%	6	15.8%	3	7.9%	0	0.0%	38	100%

#### *Side Channel Availability*

Side channel availability is considered “poor” throughout the surveyed section of the watershed. Two side channels were observed during stream surveys. These overflow channels have formed behind gravel bars. In both instances, juvenile fish with parr marks were observed (WCD 2001).

Although surveys have not been completed in the upper watershed, side-channel availability likely improves. From RM 10 through RM 12, topographic maps and aerial photographs indicate that the stream flows through a series of wetlands where side channel availability likely form. TAG members indicated that this area could provide excellent habitat for a number of anadromous species.

### *Bank Erosion / Bank Stability*

(Appendix A, Map A12)

Half of the 38 surveyed reaches of Mill Creek rated “good” for bank erosion (see Table 94). Thirteen of the remaining 19 surveyed reaches rated “poor”. At approximately RM 0.6 the creek is cutting at the toe of the hill on a broad, sweeping bend in the creek. Numerous shallow, rapid landslides are evident across the face of the bend. Some are considered recent (last 1-2 years) and other are past (5-10 years) (WCD 2001). Localized erosion concerns have been identified throughout the watershed. These areas are typically in expected locations such outside corners of stream meanders and in areas where the lack of riparian vegetation results in decreased root strength within the bank. Localized erosion was also observed in areas of flow convergence such as recent recruitment sites for LWD and around debris jams (WCD 2001).

**Table 94: Mill Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	19	50.0%	6	15.8%	13	34.2%	0	0.0%	38	100%
Total	19	50.0%	6	15.8%	13	34.2%	0	0.0%	38	100%

### *Substrate Fines*

(Appendix A, Map A13)

Table 95 provides data from Wahkiakum Conservation District stream surveys on substrate fines. Approximately half of the surveyed reaches rated “good” for fine sediment. Fourteen of the 38 surveyed reaches rated “fair”. The tidal area of Mill Creek is the only area where a significant quantity of fine sediment was observed. The substrate in lower Mill Creek, up to RM 1.5, is predominately bedrock. From RM 1.5 to RM 3 (Girl Scout camp) the stream gradient is high (2 to 5 percent) and the substrate consists of large rock, cobbles, and gravel. In several locations within this reach, large rock is accumulating to form a step-pool morphology.

**Table 95: Mill Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	20	52.6%	14	36.8%	4	10.5%	0	0.0%	38	100%
Total	20	52.6%	14	36.8%	4	10.5%	0	0.0%	38	100%

### *Riparian Conditions*

(Appendix A, Map A14)

Throughout the surveyed reaches of Mill Creek riparian conditions rated “poor”. Through the lower three miles, the poor rating is primarily due to inadequate buffer widths. From the mouth to RM 3, Mill Creek Road parallels the creek, limiting buffer width. From RM 1.5 (Spruce Creek Road Bridge) to RM 3 (Girls Scout camp) there is considerable residential development. Within this reach, riparian conditions are characterized as well mixed with conifer and deciduous species. Tree age within the buffer averages greater than 50 years. TAG members stated that a large portion of the upper watershed will soon be mature enough for another harvest cycle.

**Table 96: Mill Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	2	5.3%	25	65.8%	10	26.3%	1	2.6%	38	100%
Total	2	5.3%	25	65.8%	10	26.3%	1	2.6%	38	100%

### *Large Woody Debris*

(Appendix A, Map A15)

Throughout the surveyed portions of Mill Creek, LWD is considered to be in “poor” condition. According to Washington State Conservation Commission criteria for key pieces of LWD per channel width:

- Thirty-four (34), one thousand-foot segments were rated as being in “Poor” condition.
- One (1), one thousand-foot segment was rated as being in “fair” condition.
- Three (3), one thousand-foot segments were rated as being in “good” condition (see Table 97).

Large woody debris in the lower 1.5 miles is almost non-existent because of the incised condition of the channel. From RM 1.5 through RM 4, the amount of LWD increases significantly, but much of this material is concentrated in debris jams. Single logs functioning within the stream are rare. From RM 4 through the end of the surveyed mainstem (RM 7) the amount of LWD observed continued to increase; however, a majority of this wood is located along the channel margins.

In the lower 3,000 feet of the South Fork Mill Creek, wood is scarce within the active channel. Functioning wood observed in this area consisted of logs greater than 12 inches in diameter spanning the channel but perched from 1 to 4 feet above ordinary high water. In each instance, this wood was serving to force a pool.

**Table 97: Mill Creek Fine Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	3	7.9%	1	2.6%	34	89.5%	0	0.0%	38	100%
Total	3	7.9%	1	2.6%	34	89.5%	0	0.0%	38	100%

*Percent Pool*

(Appendix A, Map A-16)

The majority of surveyed reaches (89.5%) in Mill Creek rated “poor” for pool frequency (see Table 98). Pools from the mouth to river mile 1.5 were usually located immediately below bedrock chutes. Although scarce, these pools were large and deep providing good holding and rearing habitat. From RM 1.5 through RM 3 (Girl Scout camp) the stream is predominantly riffle habitat. For RM 3 through the end of surveyed reaches (RM 7), 2 segments rated “Fair” and 2 segments rated “Good” for pool frequency.

**Table 98: Mill Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Mill Creek	0	0.0%	4	10.5%	34	89.5%	0	0.0%	38	100%
Total	0	0.0%	4	10.5%	34	89.5%	0	0.0%	38	100%

*Water Quality*

Department of Ecology (White and Johnson 1998 and Hunter and Johnson 1996) noted a concern of aluminum toxicity and its effect on the biological communities. The TAG recalled that there is bauxite deposit in the upper watershed. Department of Ecology (Sinclair and Pitz 1999) used gauging station data to estimate the contribution of base flow (groundwater) to total streamflow during summer low-flow periods to evaluate the interrelationship between groundwater and streamflow. In the Mill Creek watershed, 92% of the total streamflow during the months of June and July is contributed by base flow. This indicates significant connectivity between groundwater and surface water in this watershed. This level of connectivity may be linked directly with concerns identified for aluminum toxicity.

Cowlitz Conservation District began monitoring stream temperature near the mouth of Mill Creek in 1997. The district expanded their activities to 4 locations in the Mill Creek watershed in 2000. Monitoring is planned annually through 2004.

Figure 13 illustrates the temperature data obtained from two mainstem Mill Creek sites during the summer of 2000. Monitoring occurred at the mouth of Mill Creek and at near RM 3. Washington State Conservation Commission criteria has been applied to the figure as two horizontal lines. These lines represent the breaks between temperature

ranges that rate condition with respect to spawning salmon needs. Washington State water quality standard for type A water is 64.4 degrees Fahrenheit. Stream temperature elevates during the summer months when it can become a concern for resident fish and rearing salmonids. Elevated temperature can represent a combined effect of a rain-dominated system, low flows, hydro-modification and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Fall coho and chinook salmon, may contend with temperatures in the “fair” to “poor” range as they first enter the system. Fairly consistent stream temperatures at both mainstem-monitoring sites may indicate that adequate shading exists between the sites to minimize any temperature increases.

**Figure 13: Mainstem Mill Creek - Year 2000 Maximum Hourly Stream Temperature**

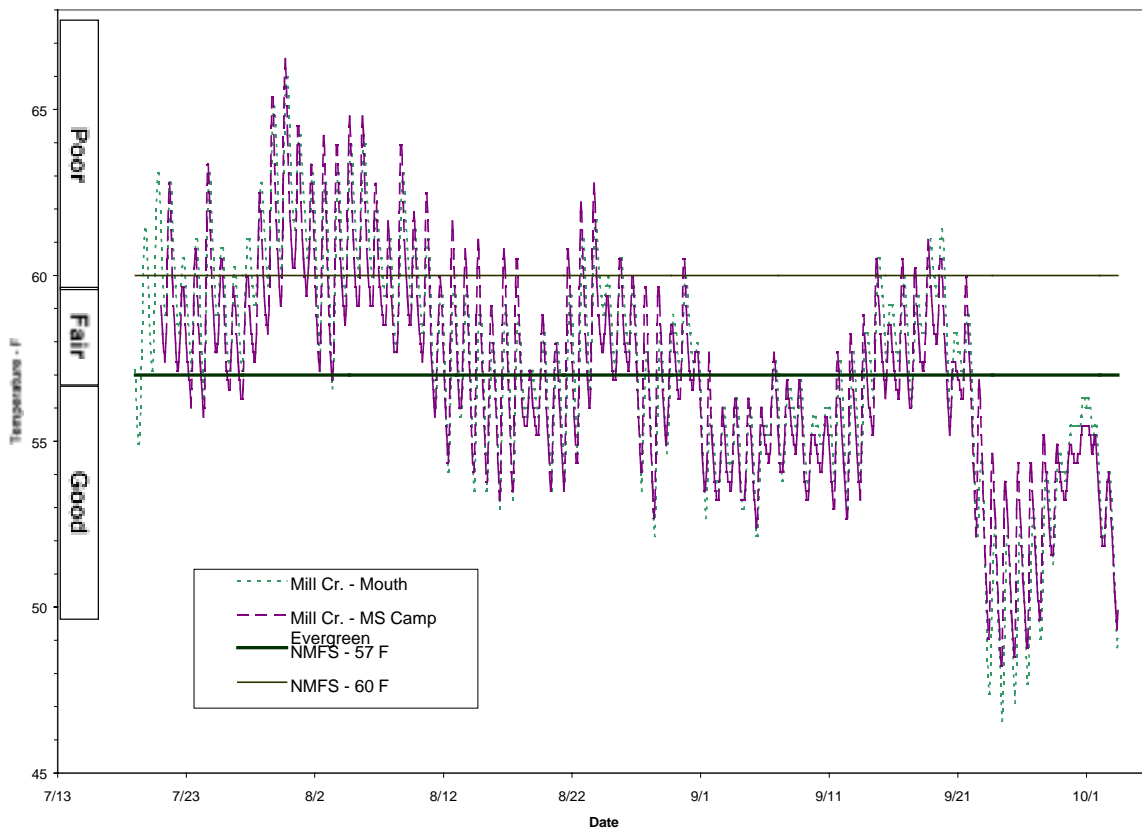
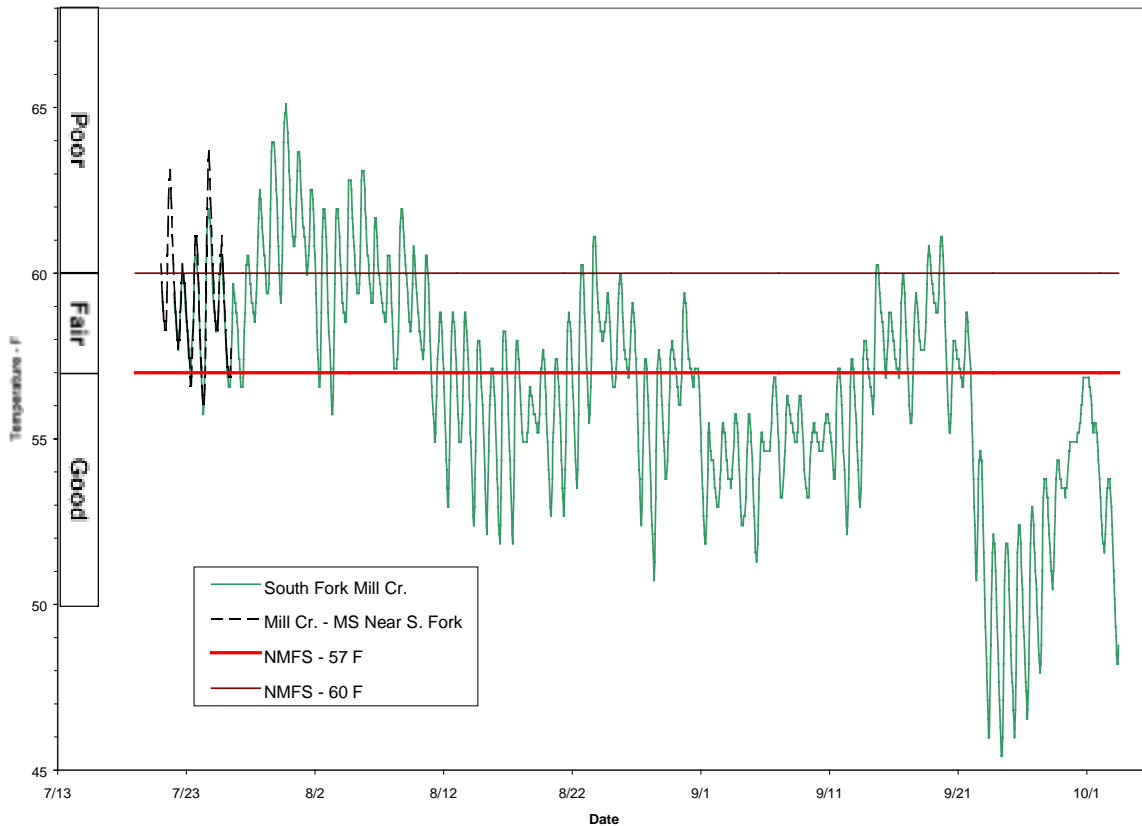


Figure 14 illustrates water temperature data collected from South Fork Mill Creek. Water temperatures follow a similar trend as that for the mainstem sites except stream temperature is typically cooler.

**Figure 14: South Fork Mill Creek - Year 2000 Maximum Hourly Stream Temperature**



### *Water Quantity*

United States Geological Survey maintained a stream flow gauging station (station # 14246500) on Mill Creek at RM 1.0. Six years of data is available between 1949 and 1956 (Williams, 1985). Temperature data was collected at this site during 1954 (USGS, 1994).

The Department of Ecology (Sinclair and Pitz, 1999) used gauging station data to estimate the contribution of baseflow (groundwater) to total streamflow during summer low-flow periods to evaluate the interrelationship between groundwater and streamflow. In the Mill Creek watershed, 92% of the total streamflow during the months of June and July is contributed by baseflow. This indicates significant connectivity between groundwater and surface water in this watershed. This level of connectivity may be linked directly with concerns for aluminum toxicity, raising concerns for groundwater contamination and withdrawals in the watershed.

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell, 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gaging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on Mill Creek upstream of the first Mill Creek Road bridge and is presented in Table 99. Streamflow spot measurements are provided in Table 100. Caldwell (1999) encourages that the data be interpreted by biologist to "determine a minimum flow regime to protect and preserve instream flow for fish". Spot flows measured in September, October, and November of 1998 (Table 100) were less than half the estimated optimum flows for salmon and steelhead rearing in Table 99, even into November. The spot flows measured on November 9, 1998 (Table 100) were slightly less than one-fifth the flows needed to support coho spawning. With such a large discrepancy between estimated optimum flows and the spot flows, additional assessment is needed for low flow characteristics on Mill Creek.

**Table 99: Toe Width Flows for Mill Creek**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
Mill Creek upstream of first road bridge	46	156.8	82.9	156.8	131.6	37.7	34.5

Caldwell et al, 1999

**Table 100: Spot Flow Measurement for Mill Creek**

Stream Name	Measured Flows (in cfs)		
	Date		
	9/15/98	10/13/98	11/9/98
Mill Creek upstream of first road bridge	9.5	11.5	16.7

Caldwell et al, 1999

*Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993). In 1951, WDF estimated that 2,700 chum spawn each year in this area, and were generally distributed in the following manner: 1,000 in Mill Creek, 300 in Abernathy Creek, 1,000 in Germany Creek, and 400 in Coal Creek. In 1954, WDF estimated the average chum escapement in Mill Creek to be 100 fish. Few chum return to spawn in Mill Creek today (TAG). SASSI (WDF et al. 1993) listed the Mill Creek coho stock as depressed and winter steelhead depressed were listed as depressed by LCSCI (Washington State 1998).

TAG members identified that large run of pea-mouth chub enter Mill Creek in April-May.

Abernathy Creek (Cameron, Slide, Weist, Midway, Erick, and Ordway Creeks)*Access*

(Appendix A, Map A-4)

Stream surveys identified a fish ladder on Cameron Creek consisting of a 5-step weir/pool facility. TAG members indicated that WDFW has three fishways on Cameron Creek. These structures were built between 1952 and 1953 under the Mitchell Act. The first is a single concrete weir located 0.4 miles upstream from the confluence with Abernathy Creek. This structure was installed to aid coho and chinook. The second structure is located at RM 0.7 and consists of 8 blasted pools/natural weirs. This second site was constructed to aid coho. The third structure is the 5-step weir/pool structure identified by stream surveyors. This structure was also intended to aid coho.

Stream surveyors indicated that the pools at the first fish ladder were full of cobble and gravel and apparently they are not maintained regularly. Stream surveyors also identified juvenile salmonids in Cameron Creek in pools immediately below the fish ladder. This

fish ladder needs additional assessment to identify fish passage problems and to document habitat conditions above the fish ladder. TAG members stated that about 3 miles of potential habitat exists above these structures.

The Abernathy Fish Technology Center maintains an electric weir. TAG members indicated that weir operation is under review and it is speculated that it will only be operative when steelhead are running (November – May). Only wild steelhead are allowed above the weir. There is a check dam with a fish ladder upstream from the hatchery. Hatchery personnel indicated that the ladder fills with sediment annually, but generally, fish are able to pass over the structure.

Bedrock at the mouth of Slide Creek may present a low-flow passage issue (TAG). A culvert on an unnamed tributary to Erick Creek at RM 2.2 may limit juvenile passage. However, this culvert is located near the upper extent of fish bearing water. TAG members identified culverts on Wiest Creek, Midway Creek, and an unnamed tributary to Abernathy Creek that need a complete fish passage assessment.

#### *Floodplain Connectivity* (Appendix A, Map A11)

Steep topography and Abernathy Creek Road confine portions of lower Abernathy Creek in several locations. The tidally influenced areas have generally good connectivity; however, TAG members indicated that there are opportunities for off channel enhancement projects in this area.

From Slide Creek to Wiest Creek (RM 1.5 to 3.4), the land use is predominantly agriculture. Abernathy Creek is unconfined but is considered slightly to moderately entrenched through this reach (WCD 2001). Stream gradients are relatively high, and bedrock is the dominant substrate throughout much of this reach. TAG members noted that splash damming was practiced in the watershed. The splash dam was located in the vicinity of the 2<sup>nd</sup> bridge on Abernathy Creek. The effects of splash damming are still evident. The lower reaches of Abernathy Creek are highly incised and the substrate is exposed bedrock in numerous locations. The water intake structure located above the hatchery may also impede sediment transport into this reach.

From Wiest Creek to Erick Creek (RM 3.4 to 5.5), Abernathy Creek is confined by Abernathy Creek Road and is considered to be slightly to moderately entrenched. From Erick Creek (RM 5.5) to the headwaters, floodplain connectivity improves. The lower portion is still confined in a few areas by Abernathy Creek Road. The surveyed extent of the upper watershed indicates good floodplain connectivity, as the creek is unconfined and not entrenched through most of this reach.

A road significantly influences floodplain connectivity along the first mile of Wiest Creek. Surveys of the upper 11,000 feet of Wiest Creek determined that that floodplain connectivity was generally good (WCD 2001).

Table 101 provides data on entrenchment from Cowlitz Conservation District stream surveys that measured valley bottom width and ordinary high water width at 200-foot intervals within each 1000-foot survey segment. Entrenchment ratios (valley bottom width/ordinary high water width) were calculated for the 200-foot observations then averaged to obtain an estimate for the entire stream segment. Rosgen (1996) entrenchment values, as adapted from the NRCS Stream Restoration Handbook, were used to apply a good, fair, and poor rating to each reach. The rating used was:

Good	Fair	Poor
$\geq 2.2$ width to depth ratio	$>1.4$ and $<2.2$ width/depth	$<1.4$

The ratings were applied to all stream segments. Information was not available to discern channel types or channel confinement. In the lower watersheds (unconfined channel types) the ratings provide an indication of entrenchment. For segments in the upper watershed (confined channel types) the values represent more of a level of confinement. 61 out of 64 surveyed reaches rated “good” for entrenchment. All surveyed reaches in other streams in the Abernathy Creek watershed rated “good” for entrenchment.

**Table 101: Abernathy Creek Entrenchment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	61	95.3%	2	3.1%	1	1.6%	0	0.0%	64	100%
Cameron Creek	3	100.0%	0	0.0%	0	0.0%	0	0.0%	3	100%
Erick Creek	14	100.0%	0	0.0%	0	0.0%	0	0.0%	14	100%
Midway Creek	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	100%
Ordway Creek	7	100.0%	0	0.0%	0	0.0%	0	0.0%	7	100%
Wiest Creek	16	100.0%	0	0.0%	0	0.0%	0	0.0%	16	100%
Total	102	97.1%	2	1.9%	1	1.0%	0	0.0%	105	100%

#### *Side Channel Availability*

Side channel availability is almost non-existent on Abernathy Creek from tidewater to the Slide Creek Bridge (TAG). Mid-channel bars are forming in the tidewater area that may help diversify habitat in the lower 2000 feet. Channel confinement limits development of side channels in the lower reaches above tidal influence. Moderate channel entrenchment limits side channel development from Slide Creek to Wiest Creek (RM 1.5 to 3.4).

#### *Bank Erosion / Bank Stability*

(Appendix A, Map A12)

Table 102 provided data from Cowlitz Conservation District stream surveys on bank erosion. Cowlitz Conservation District stream surveys identified areas where bank erosion was occurring outside of those areas where erosion is expected, such as on

outside bends, areas where the channel is constricted, or areas where flow is deflected into a bank by local conditions (see Appendix B for stream survey protocols). The data from these stream surveys was used to identify the percentage of streambanks exhibiting streambank erosion within each 1000-foot stream survey reach. This percentage was compared with the percentages for bank stability provided by the Conservation Commission's guidelines to establish "good", "fair", and "poor" ratings for bank erosion. In reviewing Map A-12, developed from the stream survey data, many TAG members stated that the data and Map A-12 underestimated the extent of bank instability and erosion occurring within many of the watersheds in WRIA 25. However, the stream survey data does provide a snapshot of erosion problems areas during the period of the stream survey work.

Few bank erosion problems were noted during stream surveys on Abernathy Creek from the tidal influence to Slide Creek. However, erosion concerns were noted in the recreation area (boat ramp and camping area).

From Slide Creek to Wiest Creek (RM 1.5 to 3.4), the land use is predominantly agriculture. Minor erosion was identified predominantly in areas where riparian vegetation has been influenced by residential development and agriculture activities.

Wiest Creek and Erick Creek were identified as having good overall bank stability. Two reaches on Erick Creek rated "fair". Erosion through these reaches was associated with channel confinement and entrenchment. Bank stability from Wiest Creek to the headwaters was rated as "good".

**Table 102: Abernathy Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	54	84.4%	8	12.5%	1	1.6%	1	1.6%	64	100%
Cameron Creek	3	100.0%	0	0.0%	0	0.0%	0	0.0%	3	100%
Erick Creek	12	85.7%	1	7.1%	1	7.1%	0	0.0%	14	100%
Midway Creek	1	100.0%	0	0.0%	0	0.0%	0	0.0%	1	100%
Ordway Creek	7	100.0%	0	0.0%	0	0.0%	0	0.0%	7	100%
Wiest Creek	16	100.0%	0	0.0%	0	0.0%	0	0.0%	16	100%
<b>Total</b>	93	95.0%	9	3.3%	2	1.5%	1	0.3%	105	100%

### *Substrate Fines*

(Appendix A, Map A13)

Table 103 provides data of substrate fines from surveyed reaches of streams in the Abernathy Creek watershed. Over 55% of the 105 surveyed reaches in this watershed had excessive amounts of fine sediment in the substrates.

Substrate fines were the dominant substrate material in the tidally influenced reaches of Abernathy Creek, and approximately 50% of the surveyed reaches rated “poor” for fine sediment. Above tidal influence to Slide Creek (RM 1.5), the streambed was scoured to bedrock. The substrate consisted of 75 percent bedrock in several of these reaches.

From Slide Creek to Wiest Creek (RM 1.5 to 3.4), substrate fines rated “good” according to LFA criteria. This reach of stream is relatively steep and bedrock is the dominant substrate material. From Wiest Creek to the headwaters, Abernathy Creek appears to be responding to increased bedload. Mid-channel bars are forming and numerous fresh deposits were noted on point bars. Even with increased bedload, these upper surveyed reaches rated from “fair to good”.

From 5000 feet to the headwaters, Wiest Creek meanders through a low gradient valley. Within these reaches, fine sediment rated “poor”. Over 85% of the surveyed reaches on Erick Creek also rated “poor” for substrate fines.

**Table 103: Abernathy Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	6	9.4%	25	39.1%	32	50.0%	1	1.6%	64	100%
Cameron Creek	1	33.3%	2	66.7%	0	0.0%	0	0.0%	3	100%
Erick Creek	0	0.0%	2	14.3%	12	85.7%	0	0.0%	14	100%
Midway Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Ordway Creek	0	0.0%	6	85.7%	1	14.3%	0	0.0%	7	100%
Wiest Creek	0	0.0%	4	25.0%	12	75.0%	0	0.0%	16	100%
Total	7	6.7%	39	38.5%	58	55.2%	1	1.0%	105	100%

### *Riparian Conditions*

(Appendix A, Map A14)

Table 104 provides data on riparian conditions from Cowlitz Conservation District stream surveys in the Abernathy Creek watershed. Approximately 61% of the 105 surveyed reaches rated “poor” for riparian conditions in the watershed according to LFA criteria. From the mouth of Abernathy Creek to Slide Creek (RM 1.5) surveyors found a good mix of immature conifer and deciduous trees along the west side of the creek. Recreational use, residential development, and the Abernathy Creek Road limit the development of riparian vegetation and adequate buffer width throughout most of this reach.

From Slide Creek to Wiest Creek (RM 1.5 - 3.4), agriculture is the predominant land use. Red alder dominates riparian vegetation through this reach and buffer widths are less than 30-feet. This vegetation is providing bank stability and potentially serving to moderate

stream temperatures, but it is limited in its capability to provide adequate LWD recruitment and other riparian functions.

From Wiest Creek to the headwaters (RM 3.4 – 10), Abernathy Creek Road limits development of riparian vegetation along one side of the creek. A mature deciduous riparian buffer of between 30 and 50 feet covers the opposite bank. The vegetation beyond the buffer is typically immature conifer that was replanted following harvest.

Bryant (1949) reported that, “The upper part of the watershed has recently been logged and burned over and is totally barren.”

**Table 104: Abernathy Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	0	0.0%	17	26.6%	47	73.4%	0	0.0%	64	100%
Cameron Creek	0	0.0%	0	0.0%	3	100.0%	0	0.0%	3	100%
Erick Creek	0	0.0%	12	85.7%	2	14.3%	0	0.0%	14	100%
Midway Creek	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1	100%
Ordway Creek	0	0.0%	2	28.6%	5	71.4%	0	0.0%	7	100%
Wiest Creek	0	0.0%	9	56.3%	7	43.8%	0	0.0%	16	100%
Total	0	0.0%	41	39.0%	64	61.0%	0	0.0%	105	100%

### *Large Woody Debris*

(Appendix A, Map A15)

According to LFA criteria, almost 80% of the surveyed reaches in the Abernathy Creek watershed had “poor” levels of LWD (see Table 105). From tidewater to the Abernathy Creek hatchery, very little woody debris was observed functioning within the stream. Riparian conditions throughout this reach are not conducive to near-term or long-term recruitment of LWD due to age, riparian width, and/or species diversity.

From the Abernathy Fish Technology Center to Midway Creek, LWD was still considered “poor”, but stream surveys found key pieces and debris jams beginning to function in the stream. LWD was not observed in the lower confined portion of Wiest Creek, and all surveyed reaches rated “poor” for LWD. LWD in Erick Creek was predominantly located in debris jams.

Key pieces of LWD continue to increase in Abernathy Creek, progressing upstream from Midway Creek. Stream survey data indicate that LWD is beginning to provide a “pool forming function” in the upper reaches of Abernathy Creek. Three of the seven surveyed reaches in Ordway Creek had “fair” LWD levels.

**Table 105: Abernathy Creek Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	0	0.0%	12	18.8%	52	81.3%	0	0.0%	64	100%
Cameron Creek	0	0.0%	1	33.3%	2	66.7%	0	0.0%	3	100%
Erick Creek	0	0.0%	5	35.7%	9	64.3%	0	0.0%	14	100%
Midway Creek	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1	100%
Ordway Creek	0	0.0%	3	42.9%	4	57.1%	0	0.0%	7	100%
Wiest Creek	0	0.0%	0	0.0%	16	100.0%	0	0.0%	16	100%
Total	0	0.0%	22	21.0%	83	79.0%	0	0.0%	105	100%

*Percent Pool*

Data from Cowlitz Conservation District stream surveys on the percentage of pool habitat in Abernathy Creek watershed is presented in Table 106. Over 90% of the surveyed reaches in the watershed rated “poor” for the percentage of pool habitat. The lower 2000 feet of Abernathy Creek is tidally influenced.

Stream surveys indicate that the majority of the pools observed in the watershed are channel formed. LWD was lacking or found along the margins of the channel and was not of sufficient size to significantly affect pool development (WCD 2001). From Slide Creek to Wiest Creek (RM 1.5 to 3.4), percent pool rated “poor”. Percent surface area in pools ranged from 5 to 20 percent within the thousand-foot segments. Throughout this reach, pools were primarily channel forced. The stream is scoured to bedrock in numerous areas throughout the reach. Stream survey data indicate that the percentage of pool habitat increases in the upper watershed and that this increase is likely related to the increase of functioning key pieces of LWD.

The percentage of pool habitat in Cameron Creek generally rated “poor”; however, it had the greatest percentage of reaches in the “fair” category. The gradient of this stream is generally steep, ranging from 3.6%-16.6% in the lower reaches. The one reach with a “fair” percentage of pool habitat in Wiest Creek also had “fair” riparian conditions.

**Table 106: Abernathy Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No data		Total	
	#	%	#	%	#	%	#	%	#	%
Abernathy Creek	1	1.6%	3	4.7%	60	93.8%	0	0.0%	64	100%
Cameron Creek	0	0.0%	1	33.3%	2	66.7%	0	0.0%	3	100%
Erick Creek	0	0.0%	2	14.3%	12	85.7%	0	0.0%	14	100%
Midway Creek	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	100%
Ordway Creek	0	0.0%	1	14.3%	6	85.7%	0	0.0%	7	100%
Wiest Creek	0	0.0%	1	6.3%	15	93.8%	0	0.0%	16	100%
Total	1	1.0%	8	7.6%	96	91.4%	0	0.0%	105	100%

### *Water Quality*

Abernathy Creek is identified on the Department of Ecology's 303(d) list (1998a) of impaired water bodies due to temperature excursions beyond state standards at 6 different locations in 1990.

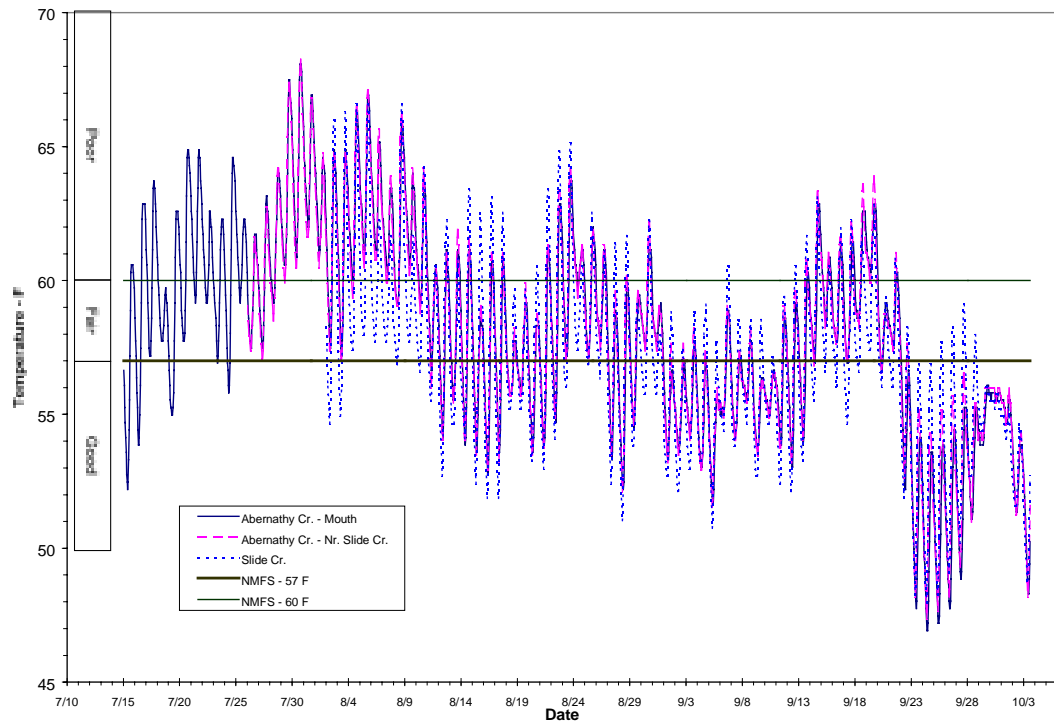
Cowlitz Conservation District has been monitoring stream temperature near the mouth, above tidewater. Unpublished data from 1997-1999 suggest that maximum stream temperatures exceed state standards through the driest, hottest months of summer. The Conservation District is currently working with Department of Ecology and local landowners to expand stream temperature monitoring locations in the Abernathy Creek watershed to 7 locations. Monitoring of water quality is planned annually through 2004. USFWS has water quality data that is still in the process of being assessed.

Figure 15 illustrates the temperature data obtained from two sites on the lower mainstem of Abernathy Creek and on Slide Creek during the summer of 2000. Figure 16 illustrates the temperature data obtained from the mid-Abernathy Creek site (at Wiest Creek road) and from the Wiest Creek site during the summer of 2000. Washington State Conservation Commission criteria has been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. An additional important line could be plotted to highlight the state water quality standard for Type A water of 64.4 degrees Fahrenheit. Stream temperatures for the mainstem sites and tributaries below the Weist Creek Bridge were elevated during the summer months when high temperature can impact resident fish and rearing salmonids. Elevated temperatures may represent the combined effect of a rain-dominated system, low flows, hydro-modifications, and the lack of streamside vegetation (shade). As Figure 16 illustrates, stream temperatures begin to decrease rapidly with the onset of fall freshets and reach "good" conditions during the majority of salmonid spawning periods. Adult coho and chinook may contend with temperatures in the "fair" to "poor" range as they first enter the system.

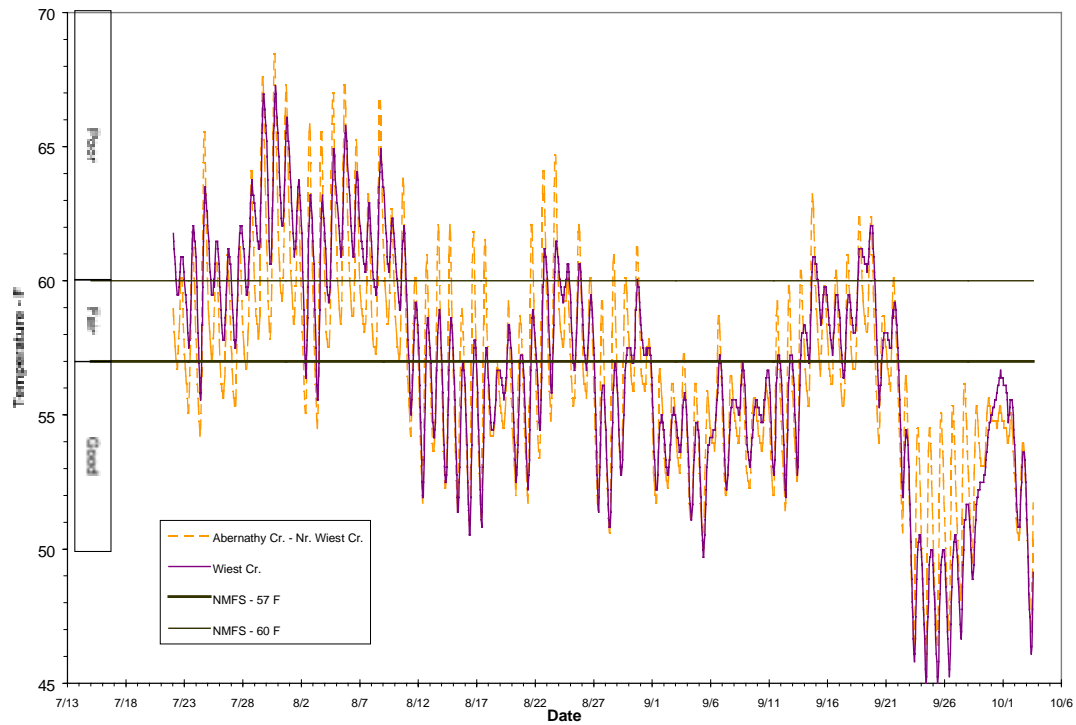
Figure 17 illustrates the temperature data collected at the uppermost site on Abernathy Creek (upstream of Midway Creek) during the summer of 2000. The data follows a similar trend as that for lower sites except stream temperature is typically cooler.

Studies by the Department of Ecology (White and Johnson 1998, Hunter and Johnson 1996) noted potential problems with aluminum toxicity in biological communities in Cameron Creek.

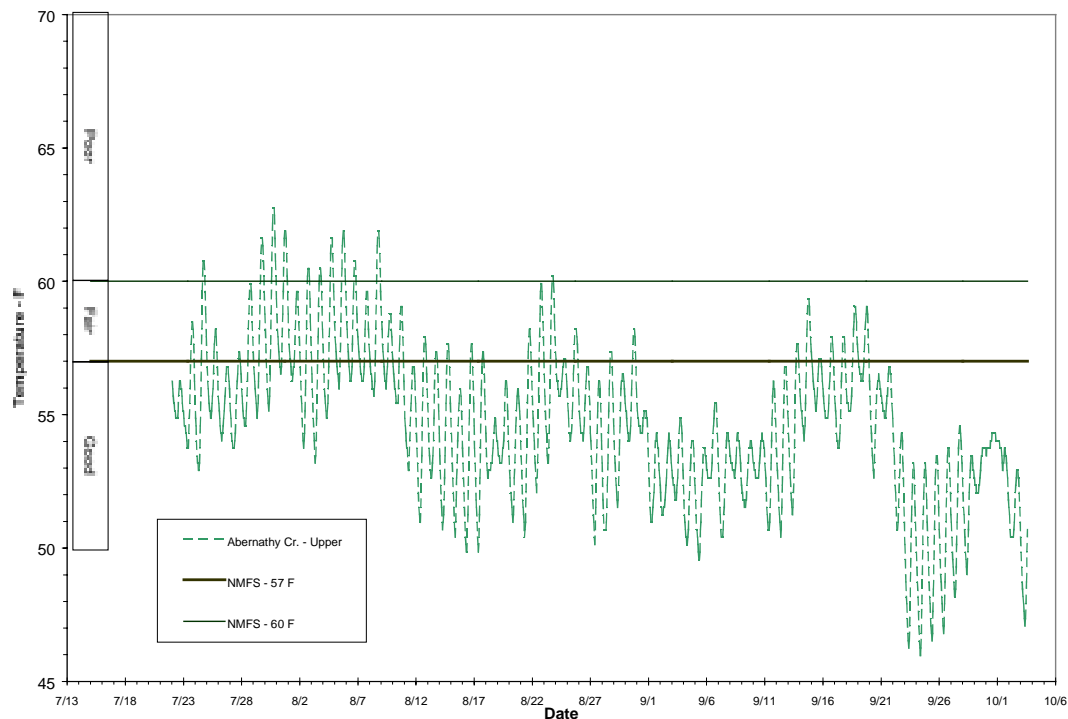
**Figure 15: Lower Abernathy - Year 2000 Maximum Hourly Stream Temperature**



**Figure 16: Mid Abernathy - Year 2000 Maximum Hourly Stream Temperature**



**Figure 17: Upper Abernathy Site - Year 2000 Maximum Hourly Stream Temperature**



### *Water Quantity*

United States Geological Survey maintained a stream flow gauging station (station # 14246000) on Abernathy Creek at RM 1.0. Data is available between 1949 and 1958 (Williams, 1985). Temperature data was collected at this site during 1950 and from 1953-1957 (USGS, 1994).

Substantial changes from historic conditions have occurred in the land cover of the Abernathy Creek Watershed Administrative Unit (WAU). Table 107 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 107 that approximately 52.5% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. Only 0.2% of the watershed's land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the watershed of greater than 4.2 miles of road/square mile also increase channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening

criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

**Table 107: Forest Seral Stage/ Land Cover in the Abernathy Creek WAU (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
<b>Abernathy Creek</b>	<b>Acres</b>	62	18149	2882	981	266	18050	40391
	<b>Percent</b>	0.2	44.9	7.1	2.4	0.7	44.7	100.0

The Department of Ecology (Sinclair and Pitz 1999) used gauging station data to estimate the contribution of baseflow (groundwater) to total streamflow during summer low-flow periods to evaluate the interrelationship between groundwater and streamflow. In the Abernathy Creek watershed, 92% of the total streamflow during the months of June and July is contributed by baseflow. This indicates significant connectivity between groundwater and surface water in this watershed.

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell, 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gauging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on Abernathy Creek at Abernathy Road and is presented in Table 108. Streamflow spot measurements are provided in Table 109. Spot flows measured in September, October, and November of 1998 (Table 109) were considerably below optimum levels identified in Table 108 for steelhead and salmon rearing, even into November. The spot flows measured on November 9, 1998 (Table 109) were less than one-fourth the flows needed to support coho spawning. With such a large discrepancy between estimated optimum flows and the spot flows, additional assessment is needed for low flow characteristics on Abernathy Creek.

**Table 108: Toe Width Flow for Abernathy Creek**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
<b>Abernathy Creek at Abernathy Creek Road</b>	43.3	145.5	76.6	145.5	122.6	34.6	31.6

Caldwell et al, 1999

**Table 109: Spot Flow Measurements for Abernathy Creek**

Stream Name	Measured Flows (in cfs)		
	Date		
	9/15/98	10/13/98	11/9/98
<b>Abernathy Creek at Abernathy Creek Road</b>	8.3	11.5	16.7

Caldwell et al, 1999

### *Biological Processes*

The Conservation Commission's Habitat Rating Standards (Appendix B) uses escapement (the number of fish returning to spawn) as a surrogate measurement for nutrient levels within streams. Salmon and steelhead returns in this subbasin are far below historical levels (WDF et al. 1993), and biological processes are likely affected by a lack of ocean-derived nutrients within the streams.

In 1951, WDF estimated that 2,700 chum spawn each year in Mill Germany and Abernathy Creeks, and they were generally distributed in the following manner: 1,000 in Mill Creek, 300 in Abernathy Creek, 1,000 in Germany Creek, and 400 in Coal Creek. In 1954, WDF estimated that 200 to 300 chum spawn in Abernathy Creek (Smith et al. 1954). Chum were also reported to use Cameron and Slide Creeks (Abernathy tributaries) (WDF 1973). Few chum now return to Abernathy Creek, and they are not considered a separate stock by WDFW (Blakley et al. 2001).

SASSI (WDF et al. 1993) considered the Abernathy Creek coho depressed based on chronically low production, and the LCSCI (State of Washington 1998) also considered Abernathy Creek winter steelhead depressed.

Fish carcasses have been placed in Abernathy Creek above Erick Creek the last few years (TAG).

### Germany Creek

#### *Access*

(Appendix A, Map A4)

A total of nine culverts and one puncheon that may limit fish passage are located on the mainstem and five unnamed tributaries, RM 9 – 12, of the upper Germany Creek watershed (refer to Map A-4). These barriers block over six miles of potential habitat. Information is limited on the condition of these culverts and the quantity and quality of available habitat above the blockages.

#### *Floodplain Connectivity*

(Appendix A, Map A11)

Table 110 provides data from Cowlitz Conservation District stream survey on measurements of valley bottom widths and ordinary high water widths at 200-foot intervals within each 1000-foot survey segment in Germany Creek. Entrenchment ratios (valley bottom width/ordinary high water width) were calculated for the 200-foot observations then averaged to obtain an estimate for the entire stream segment. Rosgen (1996) entrenchment values, as adapted from the NRCS Stream Restoration Handbook, were used to apply a “good”, “fair”, and “poor” rating to each reach. The rating used was:

Good	Fair	Poor
$\geq 2.2$ width to depth ratio	$>1.4$ and $<2.2$ width/depth	$<1.4$

The ratings were applied to all stream segments. Information was not available to discern channel types or channel confinement. In the lower watersheds (unconfined channel types) the ratings provide an indication of entrenchment. For segments in the upper watershed (confined channel types) the values represent more of a level of confinement. Over 70% of the surveyed reaches in the Germany Creek watershed were not identified as entrenched (see Table 110). Nine of the 78 surveyed reaches were considered entrenched.

The first 2,000 feet of Germany Creek is tidally influenced and exhibits generally good connectivity with its available floodplain. Germany Creek Road slightly confines this section of the stream. From RM 1.9 to RM 5.7, Germany Creek flows through agricultural land and is considered slightly entrenched. From RM 5.7 to the headwaters, Germany Creek is predominantly forested, and roads or hill slopes confine the stream.

Map A-11 illustrates that a number of reaches between RM 6 and 10 were considered entrenched or confined.

**Table 110: Germany Creek Entrenchment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	55	70.5%	14	17.9%	9	11.5%	0	0.0%	78	100%
Total	55	70.5%	14	17.9%	9	11.5%	0	0.0%	78	100%

#### *Side Channel Availability*

Stream surveys found that debris jams were serving to force a multi-thread channel in the lower 3,000 feet of the creek. Subsequent removal of debris jams by local residents is returning Germany Creek to a single thread channel (TAG). Throughout the agricultural section (RM 1.9 to RM 5.7) the stream channel is responding to an increased bedload by forming mid-channel bars and increasing lateral erosion (Schuett-Hammes 2000). This response may be adding to stream habitat diversity. However, these same processes are a major concern to landowners because they represent a loss of land or a threat to current land use practices. Through the forested reaches in the upper watershed steep hillsides and Germany Creek Road confine Germany Creek. Side channel availability is very limited in this reach.

#### *Bank Erosion / Bank Stability*

(Appendix A, Map A12)

Stream surveys of the tidally influenced area of Germany Creek determined that bank stability was generally “good”. LWD tends to accumulate in this reach and several debris jams have formed over the past few years. These debris jams tend to result in channel shifts. Locals, concerned with this localized erosion have worked to remove the debris jams. From river mile 1.5 to 6, the channel exhibits lots of instability. This instability appears to be in response to increased bedload and channel aggradation (Schuett-Hammes 2000). In several areas, mid-channel bars are forming resulting in increased erosion of channel banks. Active erosion has also been identified along the outside bend of most stream meanders. The TAG indicated growing concern from landowners regarding channel instability over the past ten years. Table 111 provides data from Cowlitz Conservation District stream surveys on bank erosion.

Department of Ecology initiated a bedload investigation in the early 1990’s as a result of logging pressure. Upper Germany watershed was logged heavily in 1970-80’s. Subsequent mass wasting delivered large volumes of material to the stream. Current monitoring by Department of Ecology (Schuett-Hammes 2000) indicates that the upper watershed is recovering. Conservation District stream surveys and landowner concerns suggest that lower Germany Creek, RM 1.5 to RM 6, is now responding to this bedload movement.

**Table 111: Germany Creek Bank Erosion (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	58	74.4%	14	17.9%	6	7.7%	0	0%	78	100%
Total	58	74.4%	14	17.9%	6	7.7%	0	0%	78	100%

*Substrate Fines*

(Appendix A, Map A13)

The tidally influenced area of Germany Creek is dominated by fine sediment. Above this reach, through agriculture land use areas (RM 1.9 to RM 5.7) increased bedload is the predominant concern. This sediment load is predominantly gravels and cobbles; however, in this area stream survey data indicates several 1,000-foot reaches that exhibit a “poor” fine sediment condition. Areas with excessive fine sediment tend to occur in lower gradient reaches and adjacent to agriculture land use with poor riparian conditions (CCD 2001). Although the upper watershed shows significant recovery from elevated sediment load, fine sediment from recent mass wasting was observed. Mass wasting may continue to be a major source of fines (Schuett-Hammes 2000). Table 112 provides data from Cowlitz Conservation District stream surveys on fine sediment condition.

**Table 112: Germany Creek Fine Sediment (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	41	52.6%	28	35.9%	9	11.5%	0	0.0%	78	100%
Total	41	52.6%	28	35.9%	9	11.5%	0	0.0%	78	100%

*Riparian Conditions*

(Appendix A, Map A14)

Table 113 provides data from Cowlitz Conservation District stream surveys on riparian conditions in Germany Creek. Over 52% of the surveyed reaches rated “poor” for riparian conditions, and none of the surveyed reaches rated “good. In the lower watershed, Germany Creek Road limits riparian width and immature deciduous trees dominate this reach. Agriculture is the predominant land use in the middle reaches of Germany Creek (RM 1.9 to RM 5.7). Riparian vegetation consisting of immature deciduous trees in widths from 30 to 50 feet characterized the reach. TAG members believed that fewer livestock had access to the creek than in past years. However, the extent of livestock access and damage to riparian habitat is unknown.

Timber in the upper watershed timber was extensively harvested in the 1980's. Previous forest practice rules left only a 30-foot riparian buffer along most of Germany Creek, resulting in generally "poor" riparian conditions in the upper watershed. These buffers contain mostly deciduous trees with immature conifer stands growing beyond 30 feet. Germany Creek Road parallels the creek throughout the upper watershed, further limiting riparian development.

**Table 113: Germany Creek Riparian (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	0	0.0%	37	47.4%	41	52.6%	0	0.0%	78	100%
Total	0	0.0%	37	47.4%	41	52.6%	0	0.0%	78	100%

### *Large Woody Debris*

(Appendix A, Map A15)

Table 114 provides data from Cowlitz Conservation District stream surveys on LWD conditions in Germany Creek. Over 78% of the surveyed reaches rated "poor" for LWD. Most of the wood within Germany Creek is located within debris jams (CCD 2001). Stream surveyors found several large debris jams in the lower 2,000 feet. These debris jams were of concern to the local community and most have since been removed. In the upper reaches of Germany Creek, one 1,000-foot stream segment rated "fair" for LWD. The upper reaches of Germany Creek had more wood than the lower reaches and contained a greater ratio of logs to debris jams. Schuett-Hammes (2000) recommends the placement of LWD in the upper watershed to increase pool habitat and to trap spawning gravel.

**Table 114: Germany Creek Large Woody Debris (LWD) (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	3	3.8%	14	17.9%	61	78.2%	0	0.0%	78	100%
Total	3	3.8%	14	17.9%	61	78.2%	0	0.0%	78	100%

### *Percent Pool*

The percentage of pool habitat in Germany Creek rated "poor" in 77 out of 78 reaches (see Table 115). In the agricultural areas (RM 1.9 to RM 5.7) pool formation was channel forced (CCD 2001). TAG members indicated that this area was responding to an excessive sediment load that may be filling pools. Observations in 1990 found that an excessive load from past land uses had reduced available pool habitat in the upper reaches of Germany Creek (Schuett-Hammes 2000). Monitoring of the same sites 10-

years later found that pool habitat was recovering as the sediment pulse moved downstream (Schuett-Hammes 2000).

**Table 115: Germany Creek Percent Pool (# of reaches and % of total)**

LFA Stream	Good		Fair		Poor		No Data		Total	
	#	%	#	%	#	%	#	%	#	%
Germany Creek	0	0.0%	1	1.3%	77	98.7%	0	0.0%	78	100%
Total	0	0.0%	1	1.3%	77	98.7%	0	0.0%	78	100%

### *Water Quality*

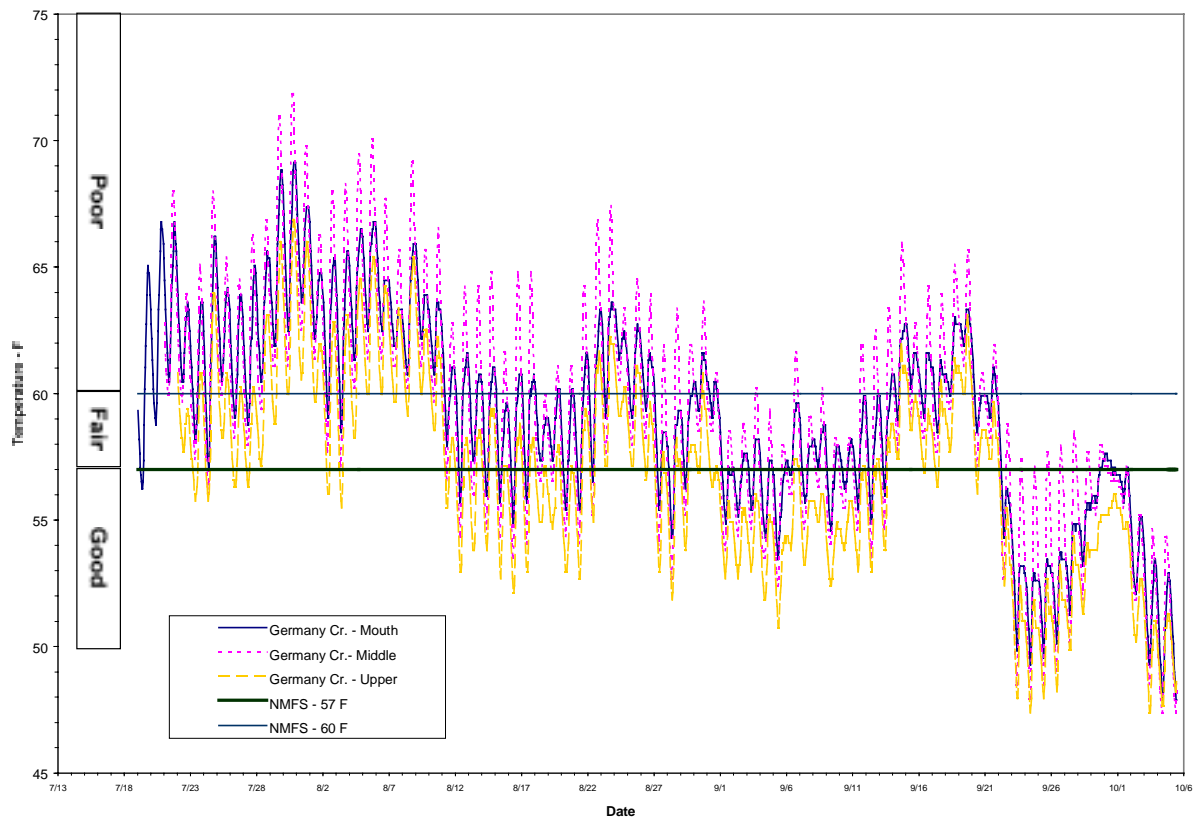
The Department of Ecology listed Germany Creek on their 1998 303d list of impaired streams for temperature (WDOE 1998a). The basis for listing is data identifying 8 temperature excursions beyond the state water quality criterion in 1988 (Sullivan 1990).

TAG members believed that stream temperature is probably a concern throughout the agriculture areas along the stream. Cowlitz Conservation District has recently expanded its water quality monitoring program to 3 sites in the Germany Creek watershed. Cowlitz Conservation District began monitoring stream temperature near the mouth of Germany Creek in 1997. The district expanded their activities to 3 locations in the watershed in 2000. Monitoring is planned annually through 2004.

Figure 18 illustrates the temperature data obtained from the Germany Creek sites during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs (see Appendix B for habitat rating standards). Washington State water quality standard for Type A water of 64.4 degrees Fahrenheit. Stream temperatures were elevated during the summer months when it is largely a concern for resident fish and rearing salmonids. Elevated temperatures likely represent the combined effect of a rain-dominated system, low flows, hydro-modification and lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets, and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Coho may contend with temperatures in the “fair” to “poor” range as they first enter the system.

Water temperatures are higher at the lower- and mid- monitoring sites than the upper watershed, supporting concerns that conditions within agricultural areas increase water temperatures in Germany Creek. The upper site follows the same temperature trends but with considerably cooler temperatures. The upper site is located at the transition to industrial forestland. Stream temperatures actually begin to cool off again from the agricultural reaches to the mouth.

**Figure 18: Germany Creek - Year 2000 Maximum Hourly Stream Temperature**



### *Water Quantity*

United States Geological Survey maintained a stream flow gauging station (station # 14245500) on Germany Creek. Data is available for 1949 (USGS, 1994).

Substantial changes from historic conditions have occurred in the land cover of the Germany Creek Watershed Administrative Unit (WAU). provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 116 that approximately 78.7% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. None of the watershed's land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the watershed of greater than 5.7 miles of road/square mile also increase channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

**Table 116: Forest Seral Stage/ Land Cover in the Germany Creek WAU (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
Germany Creek	Acres	0	3030	2040	138	110	9575	14893
	Percent	0.0	20.4	13.7	0.9	0.7	64.3	100

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gaging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on Germany Creek at Germany Creek Road and is presented in Table 117. Streamflow spot measurements are provided in Table 118. Spot flows measured in September, October, and November of 1998 (Table 118) were considerably below optimum levels identified for steelhead and salmon rearing in Table 117, even into

November. The spot flows measured on November 9, 1998 (Table 118) were less than one-third of the flow needed to support coho spawning. With such a large discrepancy between estimated optimum flows and the spot flows, additional assessment is needed for low flow characteristics on Germany Creek.

**Table 117: Toe-Width Flow for Germany Creek**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
Germany Creek at Germany Creek road	37.4	121.3	63.2	121.3	103.5	28.1	25.6

Caldwell et al, 1999

**Table 118: Spot Flow Measurements for Germany Creek**

Stream Name	Measured Flows (in cfs)		
	Date		
	9/15/98	10/13/98	11/9/98
Germany Creek at Germany Creek Road	3.7	6.6	16.1

Caldwell et al, 1999

### *Biological Processes*

Some of the TAG feels that Germany Creek is one of the most productive creeks in the sub-basin for steelhead, coho, cutthroat, and chum. The lower 4,000 feet is important chum habitat. WDFW TAG members indicated that smolt monitoring conducted in 2000 and 2001 should help determine productivity.

### Coal Creek (Mosquito and Clark Creeks)

#### *Access*

(Appendix A, Map A4)

Natural falls limit passage in Coal Creek and Mosquito (sometimes called Harmony) Creek. There may have been a splash dam located on Coal Creek (TAG). The tide gate and a culvert restrict fish passage from Coal Creek Slough into Clark Creek. Consolidated Diking Improvement District #1 indicates that the tide gate will pass fish when it is open; however, the tide gate and a culvert on Clark Creek are both protected from debris by bar screens. These screens may prevent all but smaller fish from passing between Coal Creek Slough and Clark Creek.

The TAG noted that the pumping station on Coal Creek Slough limits fish passage. The TAG identified two additional complete barriers in the Coal Creek watershed including a culvert under Carlon Loop Road on an unnamed tributary to Coal Creek and a culvert on Stewart Creek under Coal Creek Road. Within Clark Creek several (3-4) driveway culverts limit fish passage in the lower watershed (TAG). In the upper watershed a single culvert immediately below the beaver pond has a 4-foot outlet height (see Map A-4).

*Floodplain Connectivity*  
(Appendix A, Map A11)

Coal Creek is tidally influenced all the way to Mosquito (Harmony) Creek and into Longview to the pumping station on Coal Creek Slough. Willow Grove Island is entirely diked. Coal Creek is highly entrenched almost throughout the watershed (CCD 2001). Residential development also limits floodplain connectivity along most of Coal Creek.

Clark Creek is a single thread channel confined by Clark Creek Road along most of its length. The upper watershed contains a series of beaver ponds with excellent floodplain connectivity.

*Side Channel Availability*

The confined nature of this entire watershed limits side-channel development.

*Bank Erosion / Bank Stability*

Within Clark Creek, stream-adjacent roads that run for most of the stream's length have been armored in several locations (TAG). TAG members rated bank stability generally "good".

*Substrate Fines*

The confined nature of the stream channels and exposed bedrock limit the build up of any gravels or fines, except in the lower watershed where the stream is tidally influenced. The substrate that is available is surprisingly clean, given land use and road impacts (TAG).

*Riparian Conditions*

A combination of roads and land use limits riparian vegetation in lower reaches. Historic agricultural use in the upper watershed removed vegetation. Riparian conditions along Boulder Creek, a tributary to Clark Creek, were considered in better shape than the rest of the Coal Creek watershed. Overall riparian conditions were considered "poor" (TAG).

*Large Woody Debris*

Large woody debris was almost non existent throughout the entire watershed (TAG).

### *Percent Pool*

The percentage of pool habitat within the water shed is minimal (TAG). Limited riparian vegetation along with residential impacts may limit LWD recruitment and increase the peak stream flows. Coal Creek is scoured to bedrock throughout most of the main stem and in several of its tributaries.

Clark Creek is a relatively steep stream that parallels Clark Creek Road through most of its length. A steep gradient and total confinement limits pool development. Boulder Creek, entering Clark Creek  $\frac{3}{4}$  mile up from the old highway, contains excellent habitat according to the Lower Columbia Fly Fishers (Luff 2000).

### *Water Quality*

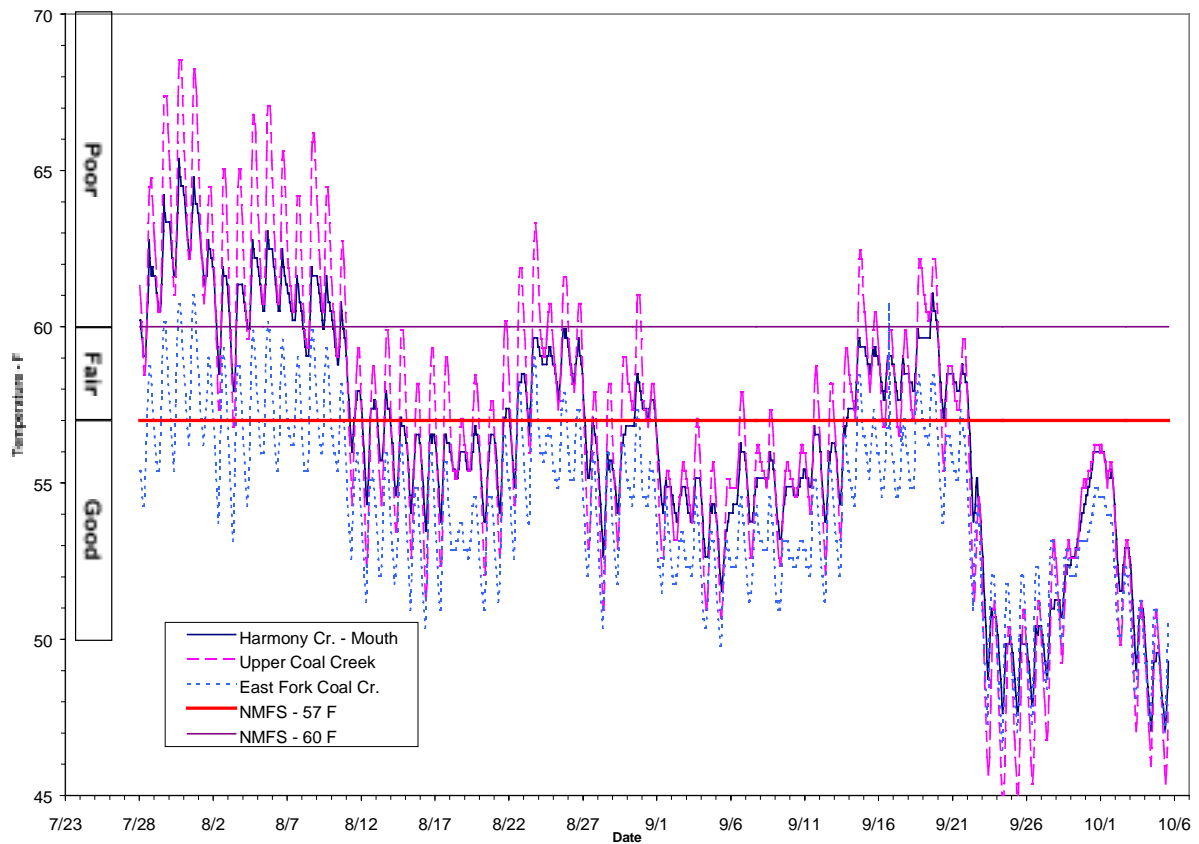
Turbidity, temperature, landfill leachate, and sewage effluent are concerns in the Coal Creek watershed. A Department of Ecology memorandum (12/3/81) indicates problems with increased turbidity due to gravel mining operations, although wastes appeared to be diluted in the marsh and may be reduced to non-problem levels. Temperatures have been at, or slightly above, 18 C. Water quality parameters characteristic with sewage effluent inputs were apparent below the West Longview Lagoon and showed a gradual decrease toward the slough mouth. Mosquito (Harmony) Creek has high fecal coliform concentrations (DOE 1981).

Cowlitz Conservation District began monitoring stream temperature in Coal Creek at four locations in 2000. Monitoring is planned annually through 2004. The recording thermograph was not recovered from the lowest site due to theft. This site would have allowed for assessment of stream temperature after passing through the developing portion of the watershed.

Figure 19 illustrates the temperature data obtained from the Coal Creek sites during the summer of 2000. Washington State Conservation Commission criteria have been applied to the figure as two horizontal lines. These lines represent the breaks between temperature ranges that rate condition with respect to spawning salmon needs. Washington State water quality standards for these Type A waters is 64.4 degrees Fahrenheit.

Stream temperature in the East Fork Coal Creek rarely exceeded 60° F during the summer of 2000. Stream temperatures at the Harmony Creek site were slightly elevated during the summer months when they may impact resident fish and rearing salmonids. The highest stream temperatures were recorded in upper Coal Creek, where even minimum stream temperatures frequently exceeded 60° F from the early part of July to early August 2000. Elevated temperature likely represent the combined effect of a rain-dominated system, low flows, hydro-modification, stormwater inputs, and the lack of streamside vegetation (shade). Temperature begins to decrease rapidly with the onset of fall freshets and stream temperatures reach “good” conditions during the majority of salmonid spawning periods. Coho, returning to spawn, may contend with temperatures in the “fair” to “poor” range as they first enter the system.

**Figure 19: Coal Creek - Year 2000 Maximum Hourly Stream Temperature**



### *Water Quantity*

Substantial changes from historic conditions have occurred in the land cover of the Coal Creek Watershed Administrative Unit (WAU). Table 119 provides land cover data that was originally derived from 1988 Landsat 5 Thematic Mapper (TM) data and was updated with 1991 and 1993 data (Lunetta et al. 1997). It is apparent from Table 119 that approximately 86.1% of the land cover in the subbasin is now in early seral stages, non-forest, and other land covers. None of the watershed's land cover is in late seral stages. Subsequently, streams within the subbasin likely experience increased magnitude, duration, and frequency of peak flows and decreased summer baseflows (Morley 2000). Road densities in the watershed of greater than 5.25 miles of road/square mile also increase channel lengths and often divert overland flows directly into stream channels, potentially contributing to increased peak flows and reduced summer flows (Booth 2000; Furniss et al. 1991).

Map A-17 illustrates the potential peak flow concerns within each Watershed Administrative Unit (WAU) of WRIA 25 (Lewis County GIS 2000). The screening

criteria used to identify WAUs within the subbasin with the potential for increased peak flows included WAUs with >3 miles of road per square mile and over 50% hydrologic immaturity based on land cover (hydrologically immature land cover was defined as early seral, non forest, and other forest, exclusive of snow-ice, sand bars, water). Functioning WAUs were considered hydrologically mature (>50% land cover in mature and/or late seral stage vegetation) and had road densities of less than 3.0 miles of road per square mile. Likely Impaired WAUs were either hydrologically immature or had road densities greater than 3.0 miles of road per square mile. Impaired WAUs were both hydrologically immature and had road densities >3.0.

**Table 119: Forest Seral Stage/ Land Cover in the Coal Creek WAU (Acres and Percent of Total)**

WAU Name	Seral Stage	Late-Seral	Mid-Seral	Early-Seral	Water	Non-Forest	Other	Total
Coal Creek	Acres	0	3258	964	43	2134	17321	23720
	Percent	0.0	13.7	4.1	0.2	9.0	73.0	100

In response to a request from the state legislature in the early 1970's, the Washington Department of Fisheries, Washington Department of Game, and the United States Geological Survey developed the Toe-Width Method to aid in determining minimum instream flows for fish (Caldwell, 1999). Development of relationships between fish habitat and streamflow requires numerous measurement of streamflow at various discharges. The toe-width method is a statistical relationship developed to minimize the need to collect numerous flow measurements in order to derive fish habitat versus streamflow relationships. Toe-width is the distance from the toe of one streambank to the toe of the other streambank across the stream channel. Using this method a statistically derived equation can be applied to the measured toe width to estimate flows that optimize habitat for spawning and rearing salmon and steelhead.

According to Caldwell (1999), Department of Ecology and Washington Department of Fish and Wildlife personnel measured "toe widths" in September 1998 on several streams in Water Resource Inventory Areas 25, 26, 28, and 29. This data was applied to WDFW Toe-Width methodology to estimate optimum streamflows. This information can be synthesized with streamflow gaging station data to assist in development of instream flows as required under Washington State Law.

Spot flow measurements were collected at the measured sites through the months of August, September, October, and November to help synthesize hydrographs. Information was collected on Coal Creek at Harmony road and is presented in Table 120. Streamflow spot measurements are provided in Table 121. As Table 121 shows, stream flows in Coal Creek were not providing optimum conditions for either rearing fish or spawning fish in September. Spot flows measurements in October and November did reach optimum for rearing fish but not for spawning needs.

**Table 120: Toe-Width Flow for Coal Creek**

Stream Name	Average Toe Width (feet)	Toe Width Flow for Fish Spawning and Rearing (cfs)					
		Chinook Spawning	Coho Spawning	Chum Spawning	Steelhead Spawning	Steelhead Rearing	Salmon Rearing
Coal Creek at Harmony Road	35.7	114.5	59.5	114.5	98.0	26.3	23.9

Caldwell et al, 1999

**Table 121: Spot Flow Measurements for Coal Creek**

Stream Name	Measured Flows (in cfs)		
	Date		
	9/15/98	10/13/98	11/9/98
Coal Creek at Harmony Road	3.8	41.2	24.1

Caldwell et al, 1999

*Biological Processes*

Habitat conditions (slack, warm water) in Coal Creek Slough may favor warm water predators of juvenile salmon and steelhead (TAG). Data on historic and current escapement to this watershed is limited.

Longview Ditches

The Longview Ditches provide a drainage network that consists of the existing slough and man made ditches. The watershed flows through the City of Longview and includes several unnamed tributary streams north of Longview.

*Access*

Fish passage is completely blocked into and out of the Longview Ditches. The only exit is through the pumping stations.

*Floodplain Connectivity*

The ditches are routinely maintained to reduce any possible connection with the floodplain.

Information is lacking on Side Channel Availability, Bank Stability, Substrate Fines, Riparian Conditions, Large Woody Debris, and Pool Frequency. Likely none of the habitat conditions within these ditches meets the Conservation Commission's habitat rating standards.

*Water Quality*

Department of Ecology is starting their Total Maximum Daily Load process on the Longview Ditches. Lake Sacajawea and the Longview Ditches are listed on DOE's list of water quality impaired water bodies (303d list). Specific parameters of concern for

Lake Sacajawea include 4,4' DDE, Chlordane, Dieldrin, PCB-1254, and PCB-1260. Specific parameters of concern for the Longview ditches include dissolved oxygen, fecal coliform, lead, and turbidity (WDOE 2000).

Several reports regarding water quality were identified for Lake Sacajawea and the Longview ditches. Gibbs & Olson (1976) reported, that Lake Sacajawea has experienced severe degradation of its water quality since it was dredged in 1924. The decomposition of large amounts of accumulated sediment on the lake bottom, the inflow water from Ditch 6, and the storm sewers are serving as major sources of nutrient supply to the lake. This supply stimulates abundant algae and aquatic plant growth, which subsequently die and contribute to the build-up of sediment on the lake bottom. In addition, Ditch 6 and the storm sewers carry considerable amounts of sediment into the lake. It was suggested that a program was needed to divert the nutrient-rich storm water runoff away from the lake and also to supply the lake with relatively nutrient-poor water from the Cowlitz River. In addition to the proposed water management, the nutrient-rich materials should be dredged from the bottom of the lake. A combination of practices can be implemented to manage processes and the restore water quality (Gibbs 1976).

Subsequent investigations were conducted to evaluate the feasibility of the practices proposed by Gibbs and Olson. In January 1978 the City of Longview received funding to evaluate 1) diversion of nutrient rich stormwater inflows away from the lake; 2) dilution and displacement of nutrient and sediment-laden lake waters with Cowlitz River water; and 3) removal of nutrients from within the lake by dredging sediments from the lake bottom. Although all elements received funding, special conditions of the grants required an initial monitoring study to sample the lake, the lake outfall, the Cowlitz River, and the ditch and storm sewers flowing into the lake. The subject report also establishes base line data needed for future use in analyzing the effectiveness of the proposed project (Gibbs 1978)

A 1981 report (LR Squier and Associates) presents the results of a geotechnical investigation undertaken in connection with the proposed dredging of Lake Sacajawea. The investigation was accomplished for lake-sediment testing, disposal area evaluation, and sedimentation testing (Squier 1981).

In 1987, Gibbs and Olson reported that, the City of Longview successfully completed a restoration program to improve the water quality of Lake Sacajawea. Specifically, the goals were to improve clarity, reduce nuisance algal blooms which caused aesthetic and odor problems during the summer, and to remove the excessive water lily growth that covered 40% of the lake's surface (Gibbs 1987).

Similar investigations have been conducted on the Longview Ditches leading to the development of a Total Maximum Daily Load, which is now underway.

Fecal coliform, high concentrations of Zinc and Iron, low dissolved oxygen (D.O.), relatively high total phosphorus, and relatively high BOD and COD were all noted as problems in a DOE memorandum dated 12/3/81.

Cowlitz Conservation District in cooperation with DOE conducted preliminary water quality investigations in the Ditch 5/10 network (Sommers 1988). Sommers reported that fecal coliform, cadmium, copper, lead, zinc, nickel, cyanide, and seven, semi-volatile organic compounds, all priority pollutants, were found but none exceeded current known standards.

A Washington Department of Ecology inspection was conducted in November 1993 at the Longview Fiber Company, Pulp and Paper Mill. The facility discharges both industrial and sanitary wastewater to the Columbia River. The inspection data found that Longview Fiber was discharging effluent concentrations within the NPDES permit limitations. Priority pollutant concentrations in the effluent for mercury, copper and lead were at or near the chronic State/USEPA Water Quality Criteria. Bioassay testing documented limited toxicity to two of the test organisms.

## **ASSESSMENT OF HABITAT LIMITING FACTORS**

The Conservation Commission reviewed several tribal, state, and federal documents that use some type of habitat rating system in order to develop a set of standards to rate salmonid habitat conditions (see Appendix B). The goal was to identify appropriate rating standards for as many types of limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the Washington Conservation Commission (WCC) adopted the accepted standard. For parameters that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed, with the expectation that it will be modified or replaced as better data become available.

The habitat condition ratings for Water Resource Inventory Area (WRIA) 25 are presented in Table 122. These ratings are not intended for use as thresholds for regulatory purposes, but as a coarse screen to identify the most significant limiting factors in WRIA 25. They also will hopefully provide a level a consistency between WRIs that allows habitat conditions to be compared across the state. However, for many habitat factors, there may not be sufficient data available to use a rating standard or there may be data on habitat parameters where no rating standard is provided. For these factors, the professional judgment of the TAG was used to assign the appropriate ratings.

The Technical Advisory Group (TAG) for WRIA 25 developed Table 122 using the habitat rating standards in Appendix B as a guide. The information for Table 122 came from both published and unpublished studies, and the personal and professional experiences of TAG members. Within some subbasins, both personal experience and quantitative data was lacking. These areas are identified with a ND (no data) designation.

In Table 123 through Table 130 are prioritized habitat limiting factors, recommendations for restoring salmonid habitat, and habitat protection priorities for each subbasin in WRIA 24 and WRIA 25 (the Chinook River, Grays River, Elochoman/Skamokawa, and Mill/Germany/Abernathy subbasins).

**Table 122: Identified habitat limiting factors for freshwater streams of WRIA 28**

Stream Name	WRIA Index	Fish Passage	Floodplain Connectivity	Bank Stability	Large Woody Debris	Percent Pool	Side Channels	Substrate Fines	Riparian Conditions	Water Quality	Water Quantity	Biological Processes
<b>Chinook Subbasin</b>												
Wallacut River		P <sup>2</sup>	ND	ND	P <sup>2</sup>	ND	ND	ND	P <sup>2</sup>	ND	ND	ND
Chinook R (to RM 2.5)		P <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	NA	P <sup>2</sup>	NA	P <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>
Chinook R (RM 2.5-4.0)		G <sup>2</sup>	P <sup>2</sup>	G <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>
Freshwater Cr.		P <sup>2</sup>	P <sup>2</sup>	ND	P <sup>2</sup>	ND	ND	P <sup>2</sup>	P <sup>2</sup>	ND	P <sup>2</sup>	P <sup>2</sup>
Kalstrom Cr.		P <sup>1</sup>	P <sup>2</sup>	ND	P <sup>2</sup>	ND	ND	F <sup>2</sup>	F <sup>2</sup>	ND	ND	P <sup>1</sup>
Chinook R (RM 4 to headwaters)		G <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	P <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>	F <sup>2</sup>
Eagle Creek		ND	ND	ND	ND	ND	ND	F <sup>2</sup>	ND	ND	ND	ND
<b>Grays River Subbasin</b>												
Sisson Creek	250058	G <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	NA	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>2</sup>	ND
Deep River	250071	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>2</sup>	P <sup>1</sup>
Campbell Creek	250076	P <sup>1</sup>	ND	ND	ND	ND	ND	P <sup>2</sup>	ND	ND	P <sup>2</sup>	P <sup>1</sup>
Lassila Creek	250077	ND	ND	ND	ND	ND	ND	P <sup>2</sup>	ND	ND	P <sup>2</sup>	P <sup>1</sup>
Salme Creek	250083	ND	ND	ND	ND	ND	ND	F <sup>2</sup>	ND	ND	P <sup>2</sup>	P <sup>1</sup>
Hendrickson Creek	250088	ND	ND	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>
Person Creek	250090	ND	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>2</sup>	P <sup>1</sup>
Crooked Creek	250173	G <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
S. Fork Crooked Cr	250175	G <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	P <sup>2</sup>	P <sup>1</sup>
Grays River (to Covered Bridge)	250093	G <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	NA	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>
Seal Creek	250104	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	ND	P <sup>1</sup>
Malone Creek	250106	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	ND	P <sup>1</sup>
Impie Creek	250114	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Nikka Creek	250115	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Thadbar Creek	250116	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Kessel Creek	250118	G <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Hull Creek	250119	P <sup>1</sup>	ND	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>
Honey Creek	250121	G <sup>2</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Fall Creek	250122	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	ND	P <sup>1</sup>
Grays River (Covered Bridge to Canyon)	250093	F <sup>2</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>
King Creek	250126	P <sup>2</sup>	P <sup>2</sup>	F <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>
Klints Creek	250128	G <sup>2</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
Crazy Johnson Creek	250139	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	P <sup>1</sup>

Stream Name	WRIA Index	Fish Passage	Floodplain Connectivity	Bank Stability	Large Woody Debris	Percent Pool	Side Channels	Substrate Fines	Riparian Conditions	Water Quality	Water Quantity	Biological Processes
Fossil Creek	250130	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>
West Fork Grays	250131	F <sup>2</sup>	NA	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Shannon Creek	250132	P <sup>2</sup>	ND	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Beaver Creek	250134	P <sup>1</sup>	ND	P <sup>2</sup>	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>
Sneigler Creek	250135	ND	ND	P <sup>2</sup>	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>
South Fork Grays Riv.	250141	G <sup>1</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	F <sup>2</sup>	P <sup>1</sup>
Blaney Creek	250142	G <sup>1</sup>	ND	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>
<b>Upper Grays</b> (Canyon to Headwaters)	250093	G <sup>1</sup>	NA	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>		
Alder Creek	250155	G <sup>1</sup>	NA	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
East Fork Grays Riv.	250157	G <sup>1</sup>	NA	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	G <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Mitchell Creek	250159	G <sup>1</sup>	NA	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Sage Creek	----	ND	NA	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Cabin Creek	250164	G <sup>1</sup>	NA	G <sup>2</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	G <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Johnson Creek	250165	ND	NA	ND	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>
<i>Elochoman/Skamokawa Subbasin</i>												
Jim Crow Creek	250187	G <sup>1</sup>	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	ND	ND
Skamokawa Creek	250194	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Alger Creek	250197	P <sup>2</sup>	P <sup>2</sup>	ND	ND	ND	ND	ND	P <sup>2</sup>	ND	ND	ND
Risk Creek	250201	P <sup>2</sup>	P <sup>2</sup>	ND	ND	ND	ND	ND	P <sup>2</sup>	ND	ND	ND
W Fork Skamokawa	250207	ND	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
West Valley Creek	250209	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Middle Valley Cr.	-----	ND		F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Cadman Creek	250210	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Kelly Creek	250212	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Eggman Creek	250213	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Wilson Creek	250215	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
N. F. Wilson	-----	ND	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Bell Canyon Creek	250216	ND	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Falk Creek	250222	ND	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Pollard Creek	250223	ND	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Left Fork Skamokawa	250224	ND	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	F <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Standard Creek	250231	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	G <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Elochoman River	250236	P <sup>2</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Nelson Creek	250241	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Beaver Creek	250247	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Beaver Cr. Trib.	-----	G <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	G <sup>1</sup>	F <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Duck Creek	250251	P <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	F <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Clear Creek	250253	P <sup>1</sup>	ND	ND	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>

Stream Name	WRIA Index	Fish Passage	Floodplain Connectivity	Bank Stability	Large Woody Debris	Percent Pool	Side Channels	Substrate Fines	Riparian Conditions	Water Quality	Water Quantity	Biological Processes
Rock Creek	250255	P <sup>1</sup>	ND	ND	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>
West Fork Elochoman	250259	G <sup>1</sup>	ND	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
N. Fork Elochoman	250264	ND	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	G <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	P <sup>1</sup>
Otter Creek	250268	ND	ND	G <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	ND	G <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	ND
Birnie Creek	250281	P <sup>1</sup>	P <sup>2</sup>	ND	ND	ND	P <sup>2</sup>	ND	ND	ND	ND	ND
Mill/Abernathy/ Germany Subbasin												
Mill Creek	250284	F <sup>1</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
South Fork Mill Creek	250285	ND	P <sup>2</sup>	ND	P <sup>1</sup>	ND	ND	ND	ND	ND	P <sup>1</sup>	ND
Spruce Creek	250288	F <sup>2</sup>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
North Fork Mill Cr	250293	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Abernathy Creek	250297	F <sup>1</sup>	F <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>
Cameron Creek	250298	P <sup>1</sup>	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	F <sup>1</sup>	P <sup>1</sup>	ND	ND	ND
Slide Creek	250302	ND	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	ND	P <sup>1</sup>	P <sup>1</sup>	ND	ND
Wiest Creek	250303	P <sup>1</sup>	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	ND	ND
Erick Creek	250304	ND	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	F <sup>1</sup>	ND	ND	ND
Midway Creek	250305	P <sup>1</sup>	G <sup>1</sup>	G <sup>1</sup>	F <sup>1</sup>	P <sup>1</sup>	ND	P <sup>1</sup>	F <sup>1</sup>	ND	ND	ND
Ordway Creek	250309	ND	G <sup>1</sup>	G <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND	F <sup>1</sup>	P <sup>1</sup>	ND	ND	ND
Germany Creek	250313	P <sup>1</sup>	G <sup>1</sup>	F <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	F <sup>2</sup>	F <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	ND
Coal Creek	250340	P <sup>2</sup>	P <sup>2</sup>	G <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	ND
Harmony (Mosquito)	250342	P <sup>2</sup>	ND	G <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	ND	F <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	P <sup>1</sup>	ND
Stewart Creek	250344	P <sup>2</sup>	ND	G <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	ND	F <sup>2</sup>	P <sup>2</sup>	ND	P <sup>1</sup>	ND
Clark Creek	250370	P <sup>2</sup>	P <sup>2</sup>	G <sup>2</sup>	P <sup>2</sup>	P <sup>2</sup>	P <sup>1</sup>	F <sup>2</sup>	P <sup>2</sup>	ND	P <sup>1</sup>	ND
Longview Ditches		P <sup>1</sup>	P <sup>2</sup>	ND	ND	ND	ND	ND	ND	P <sup>1</sup>	P <sup>1</sup>	P <sup>2</sup>

P = "Poor" as defined in Appendix B (Salmonid Habitat Condition Rating Standards)

F = "Fair" as defined in Appendix B (Salmonid Habitat Condition Rating Standards)

G = "Good" as defined in Appendix B (Salmonid Habitat Condition Rating Standards)

ND = No data. These habitat conditions need additional research to determine the condition of the habitat.

NA = Not applicable to this area.

1 = Literature source and/or stream survey data.

2 = Technical Advisory Group (TAG) assessment of habitat conditions.

## Chinook River Subbasin Stock Summary and Habitat Priorities

**Table 123: Chinook River Stocks and Priorities**

<i>SASSI and LCSCI Stocks</i>	<i>Priority</i>	<i>Other Anadromous Salmonids Present in the Sub-basin</i>
Grays River Chum Salmon (reintroduction program)	Tier 1	Fall Chinook
		Coastal Cutthroat
		Coho
		Winter Steelhead

Not all stocks are present in all parts of the subbasin. Use LFA maps or contact Gary Wade at the LCFRB for specific site information.

**Table 124: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Activities in the Chinook River Watershed\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Fish Passage</b>	<p><b>Medium/High:</b> High Priority to address tide gate passage problems in the lower Chinook River.</p> <p>Medium priority to address passage problems in the smaller Columbia River tributaries and in Freshwater Creek.</p>	<p>The tidegates on the Chinook River under Highway 101 likely restrict passage during certain flows. These tidegates alter water exchange rates and tidal influences that may create thermal and dissolved oxygen barriers under certain conditions. Remove or replace the existing tidegates at the mouth of the Chinook to reduce fish passage problems, and manage tidegates to restore tidal flushing in the Chinook River estuary.</p> <p>Tidegates on the Wallicut River under Stringtown Road may block passage at certain flows. These potential barriers need assessment and repair.</p> <p>The City water supply dam also restricts passage on Freshwater Creek, blocking approximately ½ mile of potential anadromous habitat.</p> <p>Sea Resources places a weir in to restrict passage of hatchery fish into upstream habitats from mid-September to late November. Randomly selected hatchery and native brood stock from the hatchery, and a mix of natural and hatchery fish are passed above the hatchery. After late November, all fish have unlimited access to upstream habitats.</p>	Identify and maintain connectivity between habitats that support all life history stages.

**Table 124: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Activities in the Chinook River Watershed\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
		Some of the smaller tributaries to the Columbia in WRIA 28 upstream of the Chinook River may provide potential spawning and rearing habitat. However, there is limited information on passage and habitat conditions.	
Floodplain Conditions	High: Where surveys have been completed streams are often incised and floodplain connectivity is generally “poor” in the sub-basin.	<p>Dikes, dredging, the removal of logjams, and tidegates have altered floodplain connectivity along almost all lower reaches of the Chinook River. Continue efforts to identify and restore floodplain and estuarine habitat in the lower Chinook River.</p> <p>Above tidal influence (RM 2.5) to the hatchery (RM 4), diking occurs along approximately 1/3 of the channel length. Some of the stream channel within this reach is also incised. From the hatchery intake to the headwaters, approximately 40% of the channel is noticeably incised within a wide valley. Identify and restore off-channel and side channel habitats along these reaches.</p>	<p>Protect and enhance the Chinook River Estuary. The ongoing restoration efforts by Sea Resources and its numerous partners to restore estuarine function to over 80% of the historic estuary is the largest restoration effort planned in the Columbia River basin. This effort should be fully supported.</p> <p>Preserve and enhance off-channel and side channel habitat and associated wetlands wherever they occur. Survey stream channels near the hatchery on the Chinook River to determine if there are potential sites to restore off-channel habitat to provide refuge for juvenile salmonids.</p> <p>Determine how chinook and other salmon from the Chinook River and from upstream areas of the Columbia River are using the Chinook River Estuary to better target restoration efforts.</p>

**Table 124: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Activities in the Chinook River Watershed\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Sediment</b>	<b>Medium:</b> Data is lacking on substrate conditions for most stream reaches; however, excessive sediment fines are considered a problem in some stream reaches within the sub-basin.	In the 1970's, an extensive road network was built in the upper basin and most of the watershed was logged. Over 30 large landslides and debris torrents are evident in 1974 aerial photos. These moved a tremendous amount of sediment into the stream channels and estuary (Dewberry 1997). TAG members noted that debris torrents and road culvert failures are still contributing to sediment loads in the basin, but that the extent of these problems is unknown and needs assessment. Assess and repair or decommission roads in the Chinook watershed that can contribute chronic fine sediments or may fail and lead to mass wasting and debris flows.	<p>From the Sea Resources Hatchery to the forks are the major spawning grounds for most anadromous salmonids in the Chinook River watershed. Salmon recovery efforts in the Chinook River hinge on protection and enhancement of these productive spawning grounds.</p> <p>Above the tidal reaches (RM 2.5 to the hatchery (RM 4), TAG members noted that excessive substrate fines are likely a continuing problem. Chum spawning occurs in this area, and the area needs protection and enhancement.</p> <p>Protect and enhance functional riparian corridors and identify and protect unstable slopes to reduce sediment delivery to streams. Refuge areas should be established in the basin to protect critical spawning areas by establishing a more natural regime of sediment and organic matter dynamics within the Chinook River watershed.</p>
<b>Channel/ LWD Conditions</b>	<b>High:</b> LWD levels and pool habitat are generally "poor" throughout the sub-basin. LWD recruitment	<p>Construct log jams in the lower Chinook to increase habitat diversity for rearing salmonids and to provide benefits for other species such as herring.</p> <p>LWD is the principle pool-forming agent in many of the stream systems within this subbasin. Increase functioning LWD structures, or similar natural structures, in appropriate stream reaches through LWD</p>	<p>The same reach (RM 5 to Forks) that provides critical spawning habitat for most salmon in the Chinook River also provides critical rearing habitat for most salmonids using the watershed. Protect and enhance existing instream LWD and quality pool habitat.</p>

**Table 124: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Activities in the Chinook River Watershed\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
	potential is also low.	<p>placement projects and/or through recruitment (although recruitment potential is low for most streams).</p> <p>The lack of quality pool habitat combined with low summer flows and high water temperatures likely limits available rearing habitat in the watershed. Develop and enhance pool habitat in appropriate reaches.</p> <p>LWD is often cleared from streams to reduce potential erosion. Maintain current appropriate pieces of LWD, and other natural structures, through increased education and enforcement.</p>	Protect existing mature riparian vegetation for LWD recruitment.
<b>Riparian</b>	<b>High:</b> Riparian conditions are generally “poor” throughout the sub-basin. Deciduous species and reed canary grass dominate many of the riparian corridors.	<p>Agricultural land uses have reduced or eliminated riparian cover along the lower reaches of the Chinook River. Eliminate livestock access and restore and maintain native riparian vegetation wherever possible. Target riparian restoration efforts along the most productive and/or degraded streams starting with the valley bottom and along critical spawning grounds above the hatchery.</p> <p>Deciduous species and reed canary grass dominate riparian corridors along many reaches of the Chinook. Manage riparian corridors to eliminate non-native species and increase the percentage of conifers in riparian corridors.</p>	<p>Preserve healthy riparian corridors wherever encountered in the subbasin, starting with the valley floor and along the productive spawning reaches.</p> <p>Maintain healthy riparian corridors in the upper watershed to decrease water temperatures and reduce sediment delivery to stream channels.</p>
<b>Water Quality</b>	<b>Medium:</b> Water Quality data is lacking for the Chinook River and other Columbia River tributaries.	<p>Maintain and restore riparian cover for all streams within the sub-basin, starting degraded reaches between RM 2.5 and 4.0.</p> <p>Increase water quality monitoring in the Chinook watershed to provide better guidance for restoration efforts.</p> <p>Reduce sediment delivery to stream channels.</p>	<p>Protect functional riparian corridors in all headwaters areas to maintain the supply of cool, clean water to critical downstream spawning and rearing areas.</p> <p>Protect and restore wetlands and their sources of water. Identify and protect cooler water refuges in the subbasin.</p>

**Table 124: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Activities in the Chinook River Watershed\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Water Quantity</b>	<b>Medium:</b> Both elevated peak and low flows present problems in the sub-basin.	<p>Hydrologic maturity should be improving for the Chinook River system with the re-growth of the forest after extensive logging in the 1970's. However, the high road density and loss of forest cover is likely increasing peak flows above historic levels. Reduce road densities, and the direct connections between road drainage ditches and streams to reduce peak flows, promote groundwater recharge, and potentially enhance low summer flows.</p> <p>Low flows are a natural condition for the rain and groundwater fed streams within WRIA 24. Streams, such as the Wallacut River, have minimal flow during summer months. Diversions at the Sea Resources Hatchery and from Freshwater Creek for the City of Chinook reduce flows and may reduce available rearing habitat. The impact of these diversions should be assessed and if needed adjustments in withdrawals made.</p> <p>Restore and enhance off-channel rearing habitats that can provide refuge for juveniles during peak flows, and pool habitats that can support rearing fish until water levels reconnect isolated habitats.</p>	<p>Protect fully forested and unroaded areas in the upper watershed from further development to reduce peak flows and sediment delivery to downstream habitats and provide refuges for salmonids from elevated stream temperatures.</p> <p>Preserve floodplain connections and associated wetlands to provide off-channel refuge from high flows and additional flood capacity.</p>
<b>Biological Processes</b>	<b>Medium:</b> Escapement is well below historic levels and the lack of nutrients may be limiting. Invasive species limits native riparian restoration.	<p>Increase contribution of marine-derived nutrients through increased use of carcasses.</p> <p>Encourage beaver activity in the lower Chinook River. The activity of beaver will rapidly reconnect the stream channel with the valley floor, restoring considerable freshwater habitat. According to Dewberry (1997), this single action may have the greatest short-term benefit on juvenile fish production in the basin.</p> <p>Remove reed canary grass from riparian corridors and reestablish native vegetation.</p>	<p>Preserve riparian corridors and wetlands with native vegetation.</p>

\*“Poor”, “Fair” and “Good” comments refer to habitat criteria developed by the Conservation Commission for the Habitat Limiting Factors Analysis Reports.

## Grays River Sub Basin Stock Summary and Habitat Priorities

**Table 125: Grays River Stocks and Priorities**

<b>SASSI and LCSCI Stocks</b>	<b>Priority</b>	<b>Other Anadromous Salmonids Present in the Sub-basin</b>
Grays River Chum	Tier 1	
Grays River Fall Chinook (SASSI)	Tier 2	
Grays River Coho	Tier 3	
Grays River Coastal Cutthroat (SaSI)	Tier 3	
Grays Winter Steelhead (LCSCI)	Tier 4	

Stock prioritization based on Lower Columbia Fish Recovery Board's Interim Strategy. Not all stocks are present in all parts of the sub basin. Use LFA maps for specific site information.

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<b>Limiting Factor</b>	<b>Priority Rating</b>	<b>Potential Restoration Actions</b>	<b>Preservation Actions</b>
<b>Fish Passage</b>	<b>Medium:</b> A few culverts and tidegates restrict access to habitat in the Grays sub basin.	<p>Impie Creek has a tidegate in the lower reaches that may block fish passage to 1.7 miles of habitat and it needs assessment and repair.</p> <p>A bedrock cascading falls on Hull Creek (RM 3) was retrofitted by WDFW with a fishway. This fishway has not been maintained and it has subsequently failed, blocking 1 mile of potential habitat (TAG). Blocking culverts on Nikka and Thadbar Creeks are scheduled for repair this year.</p> <p>Fish passage may be a problem through the Seal River system during certain flows, and this area needs assessment and possibly channel restoration.</p>	Identify and maintain connectivity between habitats that support all life history stages.

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Floodplain Conditions</b>	<b>High:</b> Floodplain connectivity is generally poor in most areas.	<p>The lower reaches of Deep River (RM 0 to 3.9) have been diked eliminating floodplain connections and interactions. Restore floodplain connectivity wherever possible, first focusing on areas in the lower river that might be used by both in and out of basin stocks.</p> <p>Crooked Creek has been channelized throughout the lower 2 miles and is considered highly entrenched. Restore floodplain connectivity where possible.</p> <p>The mainstem Grays River is diked to the Altoona Bridge. In conjunction with diking efforts, a large portion of the mainstem Grays River was armored. Restore off-channel and side-channel habitat wherever possible in the lower Grays.</p> <p>Many of the tributary streams to the Grays have been channelized and rerouted along the toe of the surrounding hillslopes. Streams were also entrenched and sub-surface drainage systems installed. Managed tributaries include Impie Creek, Thadbar Creek, Nikka Creek, and Seal River. Where possible, restore natural stream meander patterns and reconnect off-channel and side-channel habitats.</p> <p>Columbia Land Trust (2000) is working on acquisition and restoration projects near the mouth of Grays River that will serve to restore floodplain connectivity. Overall, the project will preserve over 500 acres and restore tidal function to 200 acres of the Gray River estuary.</p>	<p>Preserve and enhance off-channel and side channel habitat and associated wetlands wherever they occur. Protection of upstream riparian areas and overall forest cover will be needed to protect critical downstream reaches in the Grays and Fossil Creek.</p> <p>Protect and enhance functional estuarine and floodplain habitat in the lower river, especially in areas that will benefit both in basin and out of basin stocks.</p>

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i><b>Limiting Factor</b></i>	<i><b>Priority Rating</b></i>	<i><b>Potential Restoration Actions</b></i>	<i><b>Preservation Actions</b></i>
<b>Sediment</b>	<p><b>High:</b> Sediment fines and bedload deposition are significant problems in the sub basin. The upper watershed has extensive slope instability problems.</p>	<p>Aggrading streambeds in the Grays River near Gorley Springs and the lower reaches of Fossil Creek are critical spawning areas for chum. These areas have experienced major channel changes and need a geomorphological assessment to determine the best course of action to preserve and enhance critical spawning habitat in the area.</p> <p>Roads, and timber harvests have contributed to increased peak flows and numerous slope failures in the sub basin, leading to aggrading stream channels and excessive fine sediments in many areas. Restore riparian cover, reduce road densities where possible (especially in areas with unstable slopes), and reduce fine sediment delivery from roads to streams with sediment traps, filters, erosion control blankets, and by minimizing the use of fine materials in constructing stream crossings. Areas to first focus efforts include the Mitchell Creek WAU that has very high road densities, and numerous stream adjacent roads and stream crossings. Two very large slides were noted on Mitchell Creek near the 7250 Road that need assessment and potentially stabilization. A large area 12,000 feet above confluence with Grays River was highly unstable and the major source of turbidity in the South Fork. This area needs assessment and stabilization. Numerous mass wasting events in the West Fork need assessment and stabilization if possible.</p> <p>A tributary to Klints Creek contributes excessive fine sediment to the Grays River system every time it rains heavily and it needs assessment and attention.</p>	<p>The lower West Fork Grays provides critical spawning habitat for both chum and chinook.</p> <p>The mainstem Grays River and the lower reaches of its tributaries near Gorley Springs provide excellent spawning habitat for chum salmon and need protection and enhancement.</p> <p>Mitchell Creek and the East Fork Grays provide high priority steelhead habitat.</p>

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i><b>Limiting Factor</b></i>	<i><b>Priority Rating</b></i>	<i><b>Potential Restoration Actions</b></i>	<i><b>Preservation Actions</b></i>
<b>Channel Conditions/LWD</b>	<b>Medium:</b> LWD levels and pool frequencies are generally “poor” throughout the sub-basin.	<p>LWD is lacking in all anadromous streams in this sub basin due to channel cleaning, splash damming, and timber harvest. Increase functioning LWD structures, or similar natural structures to reduce stream energy and bank erosion and to increase pool habitat. Careful assessment and design is needed for any LWD project in these high-energy systems.</p> <p>Assess and reduce slope failures in the upper watershed that increase sediment loads, reduce bank stability, and fill pools in downstream reaches.</p> <p>Restore degraded riparian corridors to reduce slope instability and provide future LWD recruitment.</p>	<p>Protect existing mature riparian vegetation for LWD recruitment and to provide bank stability.</p> <p>Maintain current appropriate pieces of LWD, and other natural structures, through increased education and enforcement.</p> <p>Protect fully forested and unroaded areas in the upper Grays River watershed from further degradation to reduce peak flows and sediment inputs to downstream habitats.</p>
<b>Riparian</b>	<b>High:</b> Riparian conditions are generally “poor” throughout the sub-basin	<p>Restore riparian cover and increase the percentage of conifers in the riparian zones starting with the lower reaches of the South Fork Grays and Blaney Creek.</p> <p>TAG members noted that Alder and Johnson Creeks’ riparian zones were harvested recently, and that Mitchell Creek experienced two fires in 1978. These areas need assessment and riparian restoration.</p> <p>Most of the surveyed reaches of the West Fork need riparian restoration. The lower reaches provide critical chum and chinook spawning habitat.</p> <p>Livestock had access to streams and riparian zones in many of the agricultural areas along King, Klints, and Fossil Creeks, degrading riparian habitat. Agricultural activities also limit riparian cover along the lower mainstem Grays River. Look for opportunities to work with landowners to fence livestock from streams and restore riparian cover.</p>	<p>Preserve healthy riparian corridors in the headwaters of all the sub-basins tributaries.</p> <p>The majority of surveyed reaches along both the East Fork Grays and Cabin Creek had “fair” to “good” riparian conditions that should be protected and enhanced.</p>

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i><b>Limiting Factor</b></i>	<i><b>Priority Rating</b></i>	<i><b>Potential Restoration Actions</b></i>	<i><b>Preservation Actions</b></i>
<b>Water Quality</b>	<b>Medium:</b> Water temperature and turbidity are considered problems in a number of stream systems.	<p>Restore riparian cover for all streams within the sub-basin, focusing along degraded reaches in the West Fork, South Fork, and mainstem Grays.</p> <p>Fence livestock away from streams and riparian corridors across the sub basin.</p> <p>While data is lacking, TAG members thought that water temperatures were elevated in the South Fork Grays River. They also indicated that the South Fork is responsible for a majority of the turbidity observed in the Grays River during winter storm events. The source of this turbidity is thought to be a large active soil failure at approximately RM 3 (TAG). Restore riparian cover along the South Fork and its tributaries and assess and stabilize slope failures in the system.</p>	<p>Protect riparian corridors in all headwaters areas to maintain the supply of cool, clean water to critical downstream spawning and rearing areas.</p> <p>Protect and enhance wetland habitats in the sub basin.</p> <p>Protect the springs and seeps that chum salmon target for spawning in the Grays River and in the lower reaches of its tributaries.</p>
<b>Water Quantity</b>	<b>Medium:</b> Both elevated peak and low flows present problems in the sub-basin.	<p>In the Grays River, salmonid spawning and rearing is potentially severely compromised during the summer and early fall when flow conditions are well below optimum. Identify opportunities to augment low summer flows and create additional pool habitat in the Grays River system.</p> <p>Assess and restore flow to King Creek caused by a diversion in the upper watershed.</p> <p>All WAUs within the Grays River sub basin were considered hydrological immature, except for the South Fork WAU, and all WAUs had road densities &gt;3 miles/square mile. Decommission and/or improve roads and road crossings to increase infiltration and reduce the overall drainage network. Maintain and restore riparian and overall forest cover to increase hydrologic maturity.</p>	<p>Protect fully forested and unroaded areas in the upper watershed from further development to reduce peak flows to downstream habitats and provide refuges for salmonids from elevated stream temperatures.</p> <p>Preserve floodplain connections and associated wetlands to provide off-channel refuge from high flows and additional flood capacity.</p> <p>Protect the flow of water to springs that provide critical chum spawning habitat.</p>

**Table 126: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Biological Processes</b>	<b>Medium:</b> Escapement is well below historic levels and the lack of nutrients may be limiting. Data on invasive species is lacking for the estuary.	Increase contribution of marine–derived nutrients through increased use of carcasses.  Assess and identify alterations in the aquatic communities in the Grays Bay estuary.	Preserve riparian corridors and wetlands with intact native vegetation.

“Poor”, “Fair” and “Good” comments refer to habitat criteria developed by the Conservation Commission for the Habitat Limiting Factors Analysis Reports (see Appendix B).

## Elochoman/Skamokawa Subbasin Stock Summary and Habitat Priorities

**Table 127: Elochoman/Skamokawa Subbasin Stocks and Priorities**

<i>SASSI and LCSCI Stocks</i>	<i>Priority</i>	<i>Other Anadromous Salmonids Present in the Subbasin</i>
Skamokawa Fall Chinook (SASSI)	Tier 2	Chum Salmon
Skamokawa Coastal Cutthroat (SaSi)	Tier 3	
Skamokawa Coho (SASSI)	Tier 3	
Skamokawa Winter Steelhead (LCSCI)	Tier 4	
Elochoman Fall Chinook (SASSI)	Tier 2	
Elochoman Coastal Cutthroat (SaSi)	Tier 3	
Elochoman Coho (SASSI)	Tier 3	
Elochoman Winter Steelhead (LCSCI)	Tier 4	

Stock prioritization based on Lower Columbia Fish Recovery Board’s Interim Habitat Strategy. Not all stocks are present in all parts of the subbasin. Use LFA maps for specific site information.

**Table 128: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<i><b>Limiting Factor</b></i>	<i><b>Priority Rating</b></i>	<i><b>Potential Restoration Actions</b></i>	<i><b>Preservation Actions</b></i>
<b>Fish Passage</b>	<b>High:</b> There were a number of passage barriers identified in the subbasin	<p>Cowlitz/Wahkiakum Conservation District is currently conducting a culvert inventory for these watersheds that should provide more accurate data in the near future on passage problems.</p> <p>Dead Slough has a tide gate at the lower end (RM .2) and a gate valve on the upper end (RM 1.7) that blocks 2.3 miles of low gradient habitat. Any alterations to the existing tidegates could potentially impact water quality in Skamokawa Creek and will require careful consideration before any modifications are proposed (TAG).</p> <p>The pump station at the wildlife refuge blocks access to approximately 1.44 miles of habitat in Risk Creek.</p> <p>The tide gate on Alger Creek needs to be assessed along with two culverts near State Highway #4.</p> <p>Eggman Creek culvert, RM 2.1, has an outfall drop of three feet that blocks .4 miles of habitat.</p> <p>Kelly Creek, RM 0.1, and its Unnamed Creek have culverts that are barriers. TAG indicated that the upper watershed is in good timbered condition and supports natural wetlands that may be important habitat.</p> <p>Several unnamed tributaries to Standard Creek have passage culvert problems that need repair.</p> <p>Beaver Dam Creek (Kelly Creek on USGS 7.5-minute maps) culvert located under State Route 4 in West Valley may impair passage to 1-2 miles of habitat.</p> <p>Several passage barriers have been repaired on Birnie Creek; however, the fish screens near the mouth may block passage and need assessment and repair.</p> <p>A culvert on Nelson Creek, RM 2.0, blocks access to approximately 1.6 miles of habitat.</p>	Identify and maintain connectivity between habitats that support all life history stages.

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Fish Passage</b>		<p>Although the Beaver Creek Hatchery, RM 5, is no longer in operation, the intake dam may be a barrier, blocking 2.6 miles of habitat, and it needs assessment and repair.</p> <p>Four culverts on Duck Creek, RM 0.1 to 1.7, have outfall and gradient problems.</p> <p>Clear Creek, RM 9, culvert and the hatchery's water intake are concerns that need assessment.</p> <p>A culvert under old railroad grade and county road on Rock Creek at RM 11 blocks almost .8 miles of habitat.</p>	
<b>Floodplain Conditions</b>	<p><b>High:</b> Data is generally lacking on the condition of floodplain habitat in the subbasin</p>	<p>Dikes, numerous stream adjacent roads, and a railroad grade reduce floodplain connectivity along the Elochoman River and its tributaries. These floodplain constrictions should be assessed and improved to provide additional floodplain and off-channel habitat.</p> <p>Dikes and entrenchment also limit floodplain connections to most of the low gradient habitat in the Skamokawa Creek watershed including the mainstem Skamokawa, the West Fork Skamokawa, and Wilson, Falk, Pollard, and Bell Canyon Creeks. Where possible, restore floodplain access and connectivity.</p> <p>The Columbia Land Trust was recently awarded a grant to open up floodplain habitat adjacent to Alger Creek. Where possible, build on these restoration efforts.</p>	<p>Preserve and enhance off-channel and side channel habitat and associated wetlands wherever they occur.</p> <p>Side channels that exist in the upper segments of Wilson, Falk, and Left Fork Skamokawa Creeks need protection and enhancement.</p>

<i><b>Limiting Factor</b></i>	<i><b>Priority Rating</b></i>	<i><b>Potential Restoration Actions</b></i>	<i><b>Preservation Actions</b></i>
<b>Sediment</b>	<p><b>High:</b> Sediment fines are a significant problem in the subbasin.</p> <p>Numerous mass-wasting events occur in both the Elochoman and Skamokawa watersheds.</p>	<p>Forest practices and roads have contributed substantially to mass-wasting events in the Elochoman watershed. Prioritize identification of and avoidance of unstable slopes, and decommission or repair roads that are contributing excessive sediments to streambeds.</p> <p>TAG members noted that the West Fork Elochoman had some of the worst mass wasting, bank instability, and fine sediment problems. Avoid development on unstable slopes, repair or decommission roads and road crossings, and restore riparian vegetation, starting in areas where slope stability is a problem.</p> <p>The Wilson Creek sub-watershed had by far the highest number of mass failures/square mile of the 13 watersheds assessed by Waterstrat (1994) in Wahkiakum County.</p> <p>Jim Crow Creek watershed has very high road densities and a high rate of mass wasting that needs attention.</p> <p>Bank stability problems were noted along Skamokawa and Wilson Creeks, especially along the agricultural reaches. Eliminate livestock access and restore riparian vegetation along streams in the subbasin.</p>	<p>Protect and enhance functional riparian corridors to reduce sediment delivery to streams.</p> <p>Identify and protect limited chum spawning sites in the subbasin.</p> <p>Crippen and Standard Creeks are productive habitats for steelhead.</p>
<b>Channel/LWD Conditions</b>	<p><b>Medium:</b> LWD levels and pool habitat are generally “poor” throughout the sub-basin</p>	<p>LWD is the principle pool-forming agent in many of the stream systems within this subbasin. Increase functioning LWD structures, or similar natural structures, in appropriate stream reaches through LWD placement projects and/or through recruitment (although recruitment potential is low for most streams). Wilson Creek, the mainstem Skamokawa above tidewater, and Left Fork Skamokawa would respond well to LWD placement. Riparian vegetation in these areas will likely not be able to provide for long term LWD recruitment.</p> <p>LWD is almost non-existent in the lower reaches of the Elochoman River. Most LWD is quickly washed out of the system during high flows. In the mainstem Elochoman, pool habitats are now formed mainly by channel processes.</p>	<p>Protect existing mature riparian vegetation for LWD recruitment. Standard and McDonald Creeks were in the best condition for existing LWD in the Skamokawa Creek watershed. Riparian vegetation along these creeks should provide both near and long-term LWD recruitment.</p> <p>In the West Fork Elochoman there were some large pools with extensive cove habitat associated with logjams in the main</p>

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
<b>Channel/LWD Conditions (Continued)</b>		The lack of quality pool habitat combined with low summer flows and high water temperatures limits rearing habitat in the subbasin. Develop and enhance pool habitat in the subbasin focusing on Bell Canyon, Pollard, and Crippen Creeks.	channel. These logjams were anchored by old growth LWD with recently recruited alder LWD contributing to these formations.  Maintain current appropriate pieces of LWD, and other natural structures, through increased education and enforcement.
<b>Riparian</b>	<b>High:</b> Riparian conditions are generally “poor” throughout the sub-basin. Deciduous species dominate many of the riparian corridors.	Agricultural activities have reduced or eliminated riparian cover along the lower reaches of many streams within the subbasin. Eliminate livestock access and restore riparian vegetation wherever possible.  Target riparian restoration efforts along the most productive and/or degraded streams including the Middle Valley Skamokawa from RM 2.2-6.6, lower Wilson Creek, the lower 3 miles of Wilson Creek, all of Bell Canyon, Quarry, and Skamokawa Creeks, the lower reaches of Nelson Creek, the lower 3 miles of the West Fork Elochoman, and the mainstem Elochoman above the West Fork confluence.  Deciduous species dominate riparian corridors along a number of streams in the sub-basin. Manage riparian corridors to increase the percentage of conifers in riparian corridors.	Preserve healthy riparian corridors in the headwaters of all the sub-basins tributaries.  Protect and enhance functional riparian corridors along Standard Creek (some of the best riparian habitat in the sub-basin).
<b>Water Quality</b>	<b>High:</b> Significant water quality problems occur in the Elochoman River and Skamokawa Creek and their tributaries	Maintain and restore riparian cover for all streams within the sub-basin, especially along lower Wilson Creek where temperatures are considerably higher than found in the upper reaches.  Reduce livestock access to streams and riparian corridors.  Water quality monitoring found elevated fecal coliform and nitrate levels, thought to originate from septic systems and agricultural activities, in surface and shallow groundwater in Skamokawa watershed. Identify sources of these water pollutants and reduce inputs to stream systems.	Protect riparian corridors in all headwaters areas to maintain the supply of cool, clean water to critical downstream spawning and rearing areas.  Protect and restore wetlands.  Identify and protect cooler water refuges such as Falk Creek.

<i>Limiting Factor</i>	<i>Priority Rating</i>	<i>Potential Restoration Actions</i>	<i>Preservation Actions</i>
		Improve water quality and rearing conditions in Bell Canyon, Pollard, and Crippen Creeks.	
<b>Water Quantity</b>	<b>Medium:</b> Both elevated peak and low flows present problems in the sub-basin.	<p>By July median flows in the Elochoman dip below 40 cfs, which is less than 50% of optimal flows for steelhead and salmon spawning and rearing. Identify ways to augment low summer flows and enhance rearing habitat in the Elochoman River and other low flow limited habitats.</p> <p>Assess potential impacts on low flows in the Elochoman River from the City of Cathlamet's water withdrawals.</p> <p>Reduce road densities, and the direct connections between road drainage ditches and streams to reduce peak flows, promote groundwater recharge, and potentially enhance low summer flows.</p> <p>Restore and enhance off-channel rearing habitats that can provide refuge for juveniles during peak flows.</p>	<p>Protect fully forested and unroaded areas in the upper watershed from further development to reduce peak flows to downstream habitats and provide refuges for salmonids from elevated stream temperatures.</p> <p>Preserve floodplain connections and associated wetlands to provide off-channel refuge from high flows and additional flood capacity.</p>
<b>Biological Processes</b>	<b>Medium:</b> Escapement is well below historic levels and the lack of nutrients may be limiting.	<p>Increase contribution of marine-derived nutrients through increased use of carcasses.</p> <p>There have been reports of invasive aquatic plants in the lower reaches of streams in the sub-basin. Expand monitoring for invasive aquatic plants into the Elochoman River, Skamokawa Creek, Grays River, and Grays Bay.</p>	Preserve riparian corridors and wetlands with native vegetation.

"Poor", "Fair" and "Good" comments refer to habitat criteria developed by the Conservation Commission for the Habitat Limiting Factors Analysis Reports.

## Mill/Abernathy/Germany Subbasin Stock Summary and Habitat Priorities

**Table 129: Mill/Abernathy/Germany Stocks and Priorities**

<i>SASSI and LCSCI Stocks</i>	<i>Priority</i>	<i>Other Anadromous Salmonids Present in the Sub-basin</i>
Mill Fall Chinook (SASSI)	Tier 2	Chum Salmon
Mill Coastal Cutthroat (SaSI)	Tier 3	
Mill Coho (SASSI)	Tier 3	
Mill Winter Steelhead (LCSCI)	Tier 4	
Abernathy Fall Chinook (SASSI)	Tier 2	
Abernathy Coastal Cutthroat (SaSI)	Tier 3	
Abernathy Coho (SASSI)	Tier 3	
Abernathy Winter Steelhead (LCSCI)	Tier 4	
Germany Fall Chinook (SASSI)	Tier 2	
Germany Coastal Cutthroat (SaSI)	Tier 3	
Germany Coho (SASSI)	Tier 3	
Germany Winter Steelhead (LCSCI)	Tier 4	

Not all stocks are present in all parts of the subbasin. Use LFA maps for specific site information.

**Table 130: Prioritization of Limiting Factors and Identification of Potential Restoration and Preservation Needs\***

<b>Limiting Factor</b>	<b>Priority Rating</b>	<b>Potential Restoration Actions</b>	<b>Preservation Actions</b>
<b>Fish Passage</b>	<b>Medium/High:</b> High Priority to address passage problems in Germany and Coal Creeks where 30% and 34% of the habitat is blocked.	<p>A culvert on an unnamed tributary to Mill Creek blocks access to approximately 1.7 miles of habitat.</p> <p>Low flow passage problems on the mainstem of Mill Creek need assessment.</p> <p>TAG members identified culverts on Wiest Creek, Midway Creek, and an unnamed tributary to Abernathy Creek that need assessment and potentially repair.</p> <p>A culvert near the upper end of anadromous distribution may block access to almost a mile of habitat on Erick Creek and it needs assessment.</p>	Identify and maintain connectivity between habitats that support all life history stages.

<b>Limiting Factor</b>	<b>Priority Rating</b>	<b>Potential Restoration Actions</b>	<b>Preservation Actions</b>
<b>Fish Passage (Con't)</b>	Medium priority to assess and repair passage problems in Mill and Abernathy Creeks.	<p>Seven unnamed tributaries in the upper reaches of Germany Creek have culverts near their mouths that block between 0.2 and 1.7 miles of habitat.</p> <p>Stream surveys identified a fish ladder on Cameron Creek consisting of a 5-step weir/pool facility. Stream surveyors indicated that the pools were full of cobble and gravel and they do not appear to be maintained on a regular basis. Stream surveyors also identified juvenile salmonids in Cameron Creek in pools immediately below the fish ladder. This fish ladder could use additional assessment for passage issues and habitat condition above the fish ladder.</p> <p>Over 4 miles of potential habitat is blocked by a culvert on Clark Creek.</p> <p>A culvert on Coal Creek blocks access to approximately 0.6 miles of habitat.</p> <p>A mile of habitat is blocked by a culvert on Stewart Creek.</p>	
<b>Floodplain Conditions</b>	<b>High:</b> Where surveys have been completed streams are often incised and floodplain connectivity is generally “poor” in the sub-basin.	<p>Floodplain connectivity throughout lower Mill Creek has been impaired by past practices. Splash damming has resulted in an incised and scoured channel along most of the lower 1.5 miles. Extreme flood events are contained with the channel. Look for opportunities to reconnect off-channel and side channel habitat in Mill Creek.</p> <p>Between the mouth and RM 5.5 Abernathy Creek is confined by stream adjacent roads and/or incised in many areas. Identify opportunities to reconnect floodplain, off-channel, and side channel habitat in this reach.</p> <p>From RM 1.9 to 5.7 Germany Creek flows through agricultural land where the stream is slightly entrenched. Work with landowners to identify and reconnect productive floodplain and off channel habitat.</p> <p>Debris jams were forcing the return to a multi-thread channel in the lower 3,000 feet of Germany Creek. However, removal of debris jams by local residents is serving to return Germany Creek to a single thread. Work with landowners to identify and maintain key log jams in the lower creek.</p>	<p>Preserve and enhance off-channel and side channel habitat and associated wetlands wherever they occur. From RM 10 to RM 12 Mill Creek flows through a series of wetlands where side channel availability and floodplain connectivity improves. This area could provide excellent habitat for a number of anadromous species.</p> <p>The upper reaches of Abernathy Creek are also largely unconfined with good floodplain connectivity and need protection and enhancement.</p> <p>Preserve and enhance floodplain connectivity in lower Germany Creek.</p>

Limiting Factor	Priority Rating	Potential Restoration Actions	Preservation Actions
<b>Floodplain Conditions (continued)</b>		<p>An abandoned railroad grade that runs along the valley bottom of Abernathy Creek reduces floodplain connectivity and it needs assessment and likely decommissioning.</p> <p>Look for opportunities to reconnect floodplain habitat in the Coal and Clark Creek watersheds.</p>	
<b>Sediment</b>	<p><b>High:</b> Sediment fines and excessive bedload deposition are major problems in the some systems within the subbasin. In other streams splash damming scoured stream reaches to bedrock and areas lack suitable spawning substrates.</p>	<p>Past splash damming has scoured many of the streams in this subbasin to bedrock, leaving incised channels with limited spawning gravels. Identify areas where channel modifications (LWD or large rocks) could help slow flows, capture scarce spawning gravels, and serve to reconnect floodplain habitat. Focus first on Mill and Abernathy Creeks.</p> <p>On Germany Creek between RM 1.9 and 5.7, lower gradient reaches with poor riparian conditions and adjacent to agriculture lands had excessive percentages of fine sediments. Encourage the establishment and retention of riparian vegetation and the development of BMP's within the agriculture and residential land-use areas.</p> <p>Upper Germany watershed was logged heavily in 1970-80's. Subsequent mass wasting delivered large volumes of material to the stream. Current monitoring by Department of Ecology (Schuett-Hammes, 2000) indicates that the upper watershed is recovering. However, this large amount of material has moved to lower reaches where channel conditions are responding to increased bedload. Assess mass wasting in the watershed with specific emphasis on identifying sensitive areas, causal mechanisms, alternative management scenarios, and effects on stream channel and habitat.</p> <p>Although the upper watershed shows significant recovery from elevated sediment load, fine sediment from recent mass wasting was observed. Mass wasting may continue to be a major source of fines in Germany Creek (Schuett -Hammes, 2000). Identify unstable slopes and develop plans to avoid these areas and stabilize existing problem sites wherever possible.</p>	<p>Protect and enhance functional riparian corridors and identify and protect unstable slopes to reduce sediment delivery to streams.</p> <p>Identify and protect limited chum spawning sites in the subbasin. WDFW monitors an index area on Abernathy between tidewater and Slide Creek. Chum salmon were identified as using this area.</p>

Limiting Factor	Priority Rating	Potential Restoration Actions	Preservation Actions
<b>Channel/LWD Conditions</b>	<b>High:</b> LWD levels and pool habitat are generally “poor” throughout the sub-basin.	<p>LWD is the principle pool-forming agent in many of the stream systems within this subbasin. With a general lack of instream structural elements and elevated peak flows, streams are incised to bedrock and spawning gravels are lacking. Increase functioning LWD structures, or similar natural structures, in appropriate stream reaches through LWD placement projects and/or through recruitment (although recruitment potential is low for most streams). Areas to focus efforts include appropriate reaches of Mill Creek (from the 2nd county bridge up to the wetlands), upper Germany Creek, and on Abernathy Creek above the hatchery. Riparian vegetation in most areas will likely not be able to provide for long term LWD recruitment.</p> <p>The lack of quality pool habitat combined with low summer flows and high water temperatures limits rearing habitat in the subbasin. Develop and enhance pool habitat in appropriate reaches.</p>	<p>Protect existing mature riparian vegetation for LWD recruitment.</p> <p>LWD is often cleared from streams to reduce potential erosion. Maintain current appropriate pieces of LWD, and other natural structures, through increased education and enforcement.</p>
<b>Riparian</b>	<b>High:</b> Riparian conditions are generally “poor” throughout the sub-basin. Deciduous species dominate many of the riparian corridors.	<p>Agricultural and residential land uses have reduced or eliminated riparian cover along the lower reaches of many streams within the subbasin. Eliminate livestock access and restore and maintain riparian vegetation wherever possible.</p> <p>Target riparian restoration efforts along the most productive and/or degraded streams including the agricultural areas (generally lower and middle reaches) of Germany and Abernathy Creeks, and the residential areas of Mill Creek.</p> <p>Deciduous species dominate riparian corridors along a number of streams in the sub-basin. Manage riparian corridors to increase the percentage of conifers in riparian corridors.</p>	Preserve healthy riparian corridors wherever encountered in the subbasin, especially along areas with unstable slopes.

<b>Limiting Factor</b>	<b>Priority Rating</b>	<b>Potential Restoration Actions</b>	<b>Preservation Actions</b>
<b>Water Quality</b>	<b>High:</b> Significant water quality problems occur in Abernathy and Germany Creeks. What data exists for Mill and Coal Creeks suggests water quality problems also exist there.	Maintain and restore riparian cover for all streams within the sub-basin, especially along Abernathy and Germany Creeks, which were identified on the Department of Ecology's 303(d) list (1998a) of impaired water bodies due to temperature excursions beyond state standards.  Reduce livestock access to streams and riparian corridors.  Address water quality problems in the Longview Ditches through the TMDL process.	Protect riparian corridors in all headwaters areas to maintain the supply of cool, clean water to critical downstream spawning and rearing areas.  Protect and restore wetlands and their sources of water.  Identify and protect cooler water refuges in the subbasin.
<b>Water Quantity</b>	<b>Medium:</b> Both elevated peak and low flows present problems in the sub-basin.	September, October, and November spot flow measurements for Coal, Germany, and Mill Creeks indicated flow levels that were significantly less than optimal for spawning and rearing. Identify ways to augment low summer flows and enhance rearing habitat in these stream systems and other low flow limited habitats.  Reduce road densities, and the direct connections between road drainage ditches and streams to reduce peak flows, promote groundwater recharge, and potentially enhance low summer flows.  Restore and enhance off-channel rearing habitats that can provide refuge for juveniles during peak flows, and pool habitats that can support rearing fish until water levels reconnect isolated habitats.	Protect fully forested and unroaded areas in the upper watershed from further development to reduce peak flows to downstream habitats and provide refuges for salmonids from elevated stream temperatures.  Preserve floodplain connections and associated wetlands to provide off-channel refuge from high flows and additional flood capacity.
<b>Biological Processes</b>	<b>Medium:</b> Escapement is well below historic levels and the lack of nutrients may be limiting.	Increase contribution of marine-derived nutrients through increased use of carcasses.  Identify areas where invasive species impact the productivity of aquatic systems, and look for opportunities to reduce those impacts.	Preserve riparian corridors and wetlands with native vegetation.

“Poor”, “Fair” and “Good” comments refer to habitat criteria developed by the Conservation Commission for the Habitat Limiting Factors Analysis Reports.

## **DATA GAPS**

### **WRIA 24 Data Gaps**

Data on habitat conditions is lacking for almost all stream systems draining into the Columbia River in WRIA 24. These stream systems are on the outer boundary of Washington Department of Fish and Wildlife's Region 6, and subsequently they receive less attention. Sea Resources has begun monitoring efforts to identify water quality conditions in the Chinook River, set smolt traps and conducted snorkeling surveys to determine fish life history traits and productivity, and conducted some habitat surveys around the Chinook watershed. However, their efforts are just beginning and other stream systems that drain into the Columbia in WRIA 24 need additional data collected on habitat conditions and fish distribution and use including:

- Determine how chinook and other salmon from the Chinook River and from upstream areas of the Columbia River are using the Chinook River Estuary to better target restoration efforts.
- Continue monitoring smolt production using smolt traps in the Chinook River watershed.
- Assess and monitor the severity of predation on salmon and steelhead juveniles by warm water species in the lower reaches of the Chinook River.
- Assess and monitor the severity of predation on salmon and steelhead juveniles by Caspian terns in the Lower Chinook and Columbia River estuary.
- Conduct stream surveys to identify potential off-channel restoration sites near the hatchery complex on the Chinook River.
- Monitor fish returns by marking all hatchery fish produced at Sea Resources.
- Assess current hatchery practices to ensure that they are compatible with salmon restoration efforts.
- Identify appropriate sites to place large woody debris in the lower reaches of the Chinook River.
- Stream surveys are needed on Freshwater and Kallstrom Creeks to determine habitat conditions and species distribution by life history stage.
- Stream surveys are needed on the Wallacut River to determine habitat conditions and species distribution by life history stage.
- Stream surveys are needed on the other smaller tributaries to the Columbia River in WRIA 24 to determine habitat conditions and species distribution by life history stage.

### **WRIA 25 Data Gaps**

#### Distribution and Condition of Stocks

Information was generally lacking on the distribution and recent condition of most stocks within WRIA 25. Data on the condition of salmon stocks in the lower Columbia River was last compiled and analyzed as part of the SASSI report in 1992, and steelhead stock

condition was last published as part of the Lower Columbia Steelhead Conservation Initiative (LCSCI) in 1997. Updated information on the status of wild stocks will be critical for both focusing restoration efforts and monitoring the success of the restoration efforts. It will be important to monitor stock status by maintaining, or if possible, expanding ongoing trapping efforts and carcass and redd surveys.

It will also be important to increase the scope of existing spawning ground and stream surveys within WRIA 25. These surveys only cover a limited amount of habitat within each basin. There is minimal data on fish distribution available for areas like the smaller tributaries and floodplain habitats. Conducting additional fish surveys on smaller tributaries and in areas outside of standard index reaches would provide a much better picture of how various life-history stages for each species utilize habitat within the WRIA and will help identify where habitat may be limited.

#### Access

Various culvert inventories have been completed within portions of WRIA 25 that provide some guidance as to the severity of the barrier for both juvenile and adult passage, as well as the quality of the habitat both upstream and downstream of any blockages. However, the data collected on passage conditions at culverts and habitat conditions above culverts is not consistent with state standards. Therefore it is difficult to develop a prioritized list of actions to take both within and across subbasins. Developing a complete inventory of passage barriers, using a consistent methodology and that includes habitat surveys above and below the blockage is one of the most important steps needed for habitat restoration in WRIA 25.

Low flows also potentially limit access and movement within various watersheds throughout WRIA 25. In many areas this is a natural condition; however, bedload accumulations from excessive sediment inputs have contributed to this problem in many watersheds. Additional assessment is needed to determine the extent and potential cause of low flow problems, especially within the Grays River watershed.

#### Floodplain Connectivity

Floodplain habitat and functions have been lost or altered in most major streams within WRIA 25. Some protection and restoration of floodplain habitat has occurred in the lower floodplains of Chinook and Grays Rivers. However, these efforts cover only a small portion of the floodplain once available for salmonids.

We are gaining a better understanding of the importance of floodplain habitats, such as off-channel ponds, beaver ponds, and protected side channel sloughs, for coho and other salmonids that rely on these low-gradient areas for winter rearing habitat (Scarlett and Cedarholm 1984; Peterson and Reid 1984). Various studies (Pess et al. 1999; Beechie et al. 1994) illustrate the potential loss of productivity that occurs when floodplain habitat is lost and disconnected from river systems. Alterations of floodplain habitat in WRIA 25

often occurred early in the last century and the extent of these changes is now difficult to calculate. It will be important to identify the extent of historical floodplain habitat and then to identify areas where floodplain and off channel habitat could be enhanced or restored.

### Streambed Sediment Conditions

Wahkiakum and Cowlitz Conservation District Stream surveys noted the percentage of various sediment sizes and types within the surveyed areas of WRIA 25, but this provides only a snapshot of sediment conditions within the surveyed areas. Excessive sediment inputs and unstable spawning habitat have been identified as a major limiting factor in many of the streams in this WRIA (WDFW 2001). A comprehensive assessment of sediment sources including landslide inventories, mass wasting assessments, bank instability, and chronic erosion problems needs to be conducted in unstable watersheds using consistent methodologies. This assessment should lead to a list of priority actions to reduce sediment inputs and, where possible, address existing problems with excessive bedload deposition.

Excessive bedload deposition is especially acute within the spawning grounds of chum and chinook salmon on the Grays River. A geomorphological and hydrological assessment of the Grays watershed is needed to identify existing and potential sediment sources and to identify appropriate actions that can help stabilize conditions within the spawning grounds for both the near- and long-term.

### Channel Conditions

The Cowlitz and Wahkiakum Conservation Districts collected stream survey data on bank erosion and LWD for many of the streams within WRIA 25. This data is available and additional analysis of this data may help identify areas where specific actions are needed to restore functioning habitat. However, TAG members' felt that the bank erosion data did not accurately reflect the extensive instability of many of the stream systems within WRIA 25. Additional assessment and ground-truthing of at least a percentage of this data is needed to obtain a clearer picture of how this data can be best used.

The lack of LWD was consistent throughout WRIA 25, as it has been for most stream systems in the lower Columbia. The Cowlitz and Wahkiakum Conservation District's stream surveys also noted the amount, type, and distribution of LWD in the stream systems. Additional analysis of the LWD data, pool data, width-to-depth ratios, and riparian data may help identify areas where the lack of LWD has reduced channel complexity and where supplementation of LWD might be appropriate.

### Riparian Conditions

Riparian conditions were generally considered poor throughout WRIA 25, and riparian restoration is needed in a number of areas. However, a significant percentage of the land base is in commercial timber production where conditions are generally improving due to regulation and better management practices. Riparian condition data needs further analysis to identify the most appropriate and highest priority sites to begin restoration work. Fortunately, the most degraded areas generally occur along the agricultural reaches of most systems and riparian restoration programs already exist that can provide financial assistance for those landowners.

### Water Quality

Water quality data is generally limited within WRIA 25 to specific reaches of a few major rivers. Elevated stream temperatures are consistent problems on most systems within WRIA 25, especially within the lower elevation watersheds where land-use impacts and hydrologic modifications have been extensive. While this report identifies a number of areas where water temperatures may be limiting salmonid production, there may also be other areas within WRIA 25 with significant problems that haven't as yet been identified because of insufficient water quality monitoring. Without comprehensive coverage of all systems within the WRIA, it is difficult to pull together a picture of what types of problems are occurring and where. Water quality problems are generally no longer associated with point sources of pollution, but are now more a matter of cumulative impacts from a number of land uses across the landscape. Identifying the relationships between specific land-uses and associated water quality problems and then finding solutions to these problems, requires an extensive and ongoing monitoring program that extends into the smaller tributaries, as well as the mainstem rivers. This information can then be used to develop priorities at both the site specific and watershed scale.

Cowlitz and Wahkiakum Conservation District's are now conducting water temperature monitoring for a number of streams in WRIA 25. This data should provide a better picture of where and when water temperatures are elevated. This effort should be extended to all of the major anadromous streams and for a long enough period of time to gain a better understanding of variations due to climatic conditions.

Low flows likely contribute to elevated water temperatures in many stream systems within WRIA 25. While summer flows are naturally low in most streams within the WRIA, excessive bedload and high width-to-depth ratios contributes to these temperature problems. A comprehensive assessment of all factors contributing to elevated water temperatures is needed to successfully resolve these problems.

## Water Quantity

The Department of Ecology, in cooperation with the Department of Fish and Wildlife, conducted an instream flow study at various isolated sites on many of the stream systems within WRIA 25. While the study identified the optimum flow for both spawning and rearing for various species, it did not identify flows necessary for incubation of fish eggs, smolt out-migration, fish passage to spawning grounds, and prevention of stranding fry and juveniles. Meeting these needs is required when setting minimum instream flows. Nor did the study consider other variables that might also be impacted by low flows such as water temperature, water quality, and sediment load (Caldwell et al. 1999). The IFIM and Toe-Width studies collected only a limited amount of flow data for smaller tributaries in WRIA 25 during the summer months of 1998, and only for a limited number of sites. This data collection process could be expanded, and include a process for identifying necessary flows for other life-history stages.

The data from Ecology's IFIM study shows that low-flow may be limiting rearing habitat for salmonid juveniles in most measured streams during the summer and fall months. These are also the times when elevated water temperatures stress juveniles rearing in already limited habitat. The combination of these factors needs additional research to determine the impacts to fish that must find suitable year-round rearing habitat within fresh water. It will be important to incorporate this additional information into the models before determining appropriate minimum instream flows.

Most of the stream gauges that could provide critical information on stream flows within WRIA 25 are no longer in use. The TAG suggested restoring and monitoring as many of these gages as possible. Only with long-term flow data can many of the associations be identified between alterations in land use, streamflow, and habitat conditions.

Elevated peak flows have likely contributed to many problems that are occurring in stream channels (high width-to-depth ratios, excessive bedload in areas, channels scoured to bedrock, bank and substrate instability). The Conservation Commission uses land cover as a surrogate measurement to determine changes in peak flow within a basin. Long-term stream flow gaging would provide a much more accurate picture of what is occurring in watersheds, and provide much better direction for restoration and protection efforts.

## Biological Processes

Escapement for most anadromous salmonids is well below historic levels, and aquatic ecosystems are likely negatively affected by the loss of nutrients. Assessment of nutrient levels within the various subbasins is needed to quantify the extent of the impacts to aquatic communities as well as the potential to enhance salmonid habitat with carcass planting.

Surveys of the aquatic macroinvertebrate community can provide an excellent baseline indicator of habitat quality and aquatic conditions, and they can be easily duplicated at a later date to monitor changes within stream systems. This type of baseline data is needed for all major streams within WRIA 25.

There are a number of areas where hydrological modifications, introduced species, and hatchery operations may be favoring salmonid predators, and increasing the spread of disease and competition for limited resources. The extent of these impacts is generally unknown, and assessment of the potential impacts to salmonids from these activities will be especially important within Grays Bay and other tidally influenced areas where substantial changes have occurred in estuarine function.

Non-native plant species, such as reed canary grass and Himalayan blackberries inhibit the reestablishment of native riparian vegetation. Numerous riparian restoration projects are underway within WRIA 25, and there have been a variety of methods used to remove invasive species and reestablish native plants. It will be important to monitor the success of these projects and the various methods used to help guide future riparian restoration projects.

#### Habitats in Need of Protection

Identification of important habitats that need protection within WRIA 25 was based on the collective knowledge of the TAG members. While the fisheries and habitat experts on a stream system are likely to identify most of the critical habitats in a watershed, it would be important to develop a standardized methodology for identifying these areas that could then be applied consistently within stream systems, as well as across the region. This standardized methodology would also help identify specific data gaps.

Additional data on the distribution and abundance of the various species during all life-history stages would also benefit the analysis of which habitats are truly the most critical to protect within each watershed. This baseline information is necessary to both identify critical areas for each life-history phase and to monitor recovery success over time.

#### **Grays River Subbasin Data Gaps**

There are a number of artificial and natural barriers identified in tributaries to Grays Bay that need additional assessment. Stream surveys have identified potential barriers in the watershed but a standard accepted protocol has not been applied to many of the passage barriers in the watershed. Replacement and repair of culverts is often expensive. With the limited funds available for salmon restoration it is critical to first address the most significant limiting factors in the watershed. A complete, standardized barrier assessment is needed of the Grays River watershed to determine the extent of any passage problems and the quality and quantity of any habitat upstream of the barriers so that culvert projects can be prioritized.

Substantial losses of estuarine and wetland habitat have occurred in the lower Grays River due to flood protection activities. A complete survey of the floodplain to identify hydromodifications and potential restoration actions is needed. Identification and restoration of disconnected floodplain habitats could also benefit flooding concerns for local residents.

According to the Bottom et al. (2001 In Review) “Despite a few ecological surveys of fish assemblages and food webs (Haertel and Osterberg 1967: Bottom and Jones 1990), the estuarine life-histories of salmon and the physical and biological processes that affect their habitats in the Columbia River estuary have been rarely investigated and poorly understood.” The location of Grays Bay and its tributaries within the oligohaline-brackish transition zone of the Columbia River estuary suggest that both freshwater and oligohaline wetlands within this area may be important staging areas and transition zones, particularly for subyearling salmon when they first encounter and must acclimate to salt water (Northwest Fisheries Science Center Draft 2001). It will be very important to gather data on how juveniles use these areas within the lower Grays River, Deep River and other tributaries to Grays Bay. It is important to know whether this area is used by upper Columbia River migrants as well as local stocks, and to identify potential restoration projects within these transition zones. Information is also lacking on the effect tidegates have on juvenile fish passage into these critical rearing areas, and the effects of tidegates on estuarine function.

Stream surveys were not conducted on Sneigiler Creek, Crazy Johnson, and Johnson Creek in the Grays River watershed. The TAG was not able to add much information regarding habitat conditions in these streams. Several locations in the Grays River and two sites in the Crooked Creek watershed need further assessment to determine barrier status and potential upstream habitat. Grays River assessment needs include Malone Creek, Hull Creek, Silver Creek a tributary to Hull Creek, Impie Creek, South Fork Grays, Blaney Creek and the mainstem Grays River in the upper watershed. Data is also lacking on water quality and quantity, available spawning habitat, fish distribution and condition in most of these streams.

Large sediment loads continue to affect stream channels in the Grays River watershed. It appears that Grays Bay, the mouth of the Grays River, and critical chum and chinook spawning reaches have aggraded considerably over the last few decades; leading to a lack of deep-water refuge and cover, potential passage problems, substrate instability, and significant localized flooding (TAG). Both chum and chinook salmon spawn mainly in the mainstem Grays River where substrate and channel conditions are highly unstable. It is critical to determine the extent of the problem in these spawning reaches and to identify actions that can reduce impacts to listed chum and chinook stocks. This will likely require a complete geomorphological and hydrological assessment of upstream reaches, and a comprehensive assessment of existing and potential spawning areas. TAG members identified the South and West Fork Grays Rivers as areas where mass wasting and erosion were the greatest concern. Assessment of these watersheds should receive the highest priority.

## **Elochoman/Skamokawa Subbasin Data Gaps**

There are a number of artificial and natural barriers identified in the Elochoman/Skamokawa Subbasin that need additional assessment. Stream surveys have identified potential barriers in many areas of the Subbasin watershed but a standard accepted protocol has not been applied to many of the passage barriers in the watershed. A complete, standardized barrier assessment is needed of the Subbasin to determine the extent of any passage problems and the quality and quantity of any habitat upstream of the barriers. Information is lacking on the effects of tidegates and other water control structures on the quantity and quality of anadromous habitat in Skamokawa Creek.

A number of important anadromous tributaries have not had stream surveys in the Subbasin including Standard and McDonald Creeks, Jim Crow Creek, and Alger Risk, and Birnie Creeks.

Little information is available regarding the quantity of rearing and spawning habitat and current utilization of habitat in the Skamokawa Creek watershed. High stream temperatures and the lack of quality pools may limit rearing habitat in the Skamokawa Creek watershed (TAG), and these conditions need additional assessment.

TAG members indicated that several sites have been selected to reestablish chum in Skamokawa Creek. WDFW now maintains an index area for chum salmon at one of these sites located on the Middle Valley Skamokawa Creek, just downstream of Crippen Creek. They consistently monitor about 30 pairs using this site. These efforts need to continue along with monitoring of the success of the reintroduction efforts.

TAG members noted that side channel habitat is very limited in the Elochoman River watershed. Some side channel habitat exists both upstream and downstream of the Beaver Creek Hatchery that is now disconnected from the river except at the higher flows. Surveys are needed to identify opportunities to restore side-channel in important spawning and rearing areas.

Information is not available regarding chum salmon distribution and utilization in the Elochoman River watershed. At one time this area supported substantial chum runs and the potential exists to increase production within the watershed. TAG members indicated that there is an effort underway to use infrared photography to assess availability of preferred chum habitats (springs) particularly in the Beaver Creek area. These assessment efforts should be supported.

## **Mill/Abernathy/Germany Subbasin**

There are a number of artificial and natural barriers identified in the Mill/Abernathy/Germany Subbasin that need additional assessment. Stream surveys have identified potential barriers in many areas of the subbasin but a standard accepted protocol has not

been applied to many of the passage barriers in the watershed. A complete, standardized barrier assessment is needed of the Subbasin to determine the extent of any passage problems and the quality and quantity of any habitat upstream of the barriers.

Stream surveys have only been completed on about 8 miles of the mainstem of Mill Creek. The rest of the anadromous zone needs assessment. Information is limited regarding quantity of habitat and fish utilization in Spruce Creek. Stream surveys were not conducted above the Cameron Creek fish ladder or in Slide Creek. TAG members felt that steelhead may utilize Cameron Creek.

WDFW monitor an index area between the tidewater of Abernathy Creek to Slide Creek. Monitoring identified chum using this area, but the distribution of chum spawning is unknown. There may be springs and seeps in the watershed that could provide quality spawning habitat for chum, and these areas need to be identified and protected and/or restored.

Abernathy Creek hatchery staff indicated that the streambed near the hatchery has received increased bedload recently. They removed 190 yards of silt from the water-intake structure and conveyed that their maintenance needs are increasing. A geomorphic assessment of the reaches upstream of the hatchery is needed to characterize sediment inputs and identify potential actions to reduce excessive sediment inputs into the watershed.

An abandoned railroad grade runs up the valley bottom of Abernathy Creek, sometimes running in the streambed. Additional assessment is needed to determine the impacts from the railroad grade and identify potential restoration actions.

TAG members noted that excessive sediment inputs had altered the channel characteristics of Germany Creek. A large sediment pulse that originated from sources in the upper watershed is moving downstream and impacting habitat quality in lower reaches. WDOE staff (Schuett-Hammes 2000) have been monitoring channel changes due this large sediment pulse. This effort should continue, and potential restoration actions need to be identified that can minimize the impacts to downstream habitats.

There is limited habitat available in the Coal Creek watershed, largely due to a number of passage barriers. This watershed needs additional assessment to identify and prioritize passage barriers and restoration actions.

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## APPENDICES

### Appendix A: Maps

Several maps have been included with this report for your reference. The maps are appended to the report as a separate electronic file. The maps are included as a separate electronic file to enable the reader to utilize computer multi-tasking capabilities to simultaneously bring up the map and associated text. For printed hard copies of the report add the 11 by 15 inch maps to this appendix. Below is a list of maps that are included in the WRIA 25 map appendix/file:

Grays River Subbasin Location and Barriers	Map-A2
Skamokawa-Elochoman Subbasin Location and Barriers	Map-A3
Germany-Abernathy Subbasin Location and Barriers	Map-A4
Major Public Lands	Map-A5
Coho Salmon Distribution	Map-A6
Winter Steelhead Distribution	Map-A7
Fall Chinook Distribution	Map-A8
Chum Distribution	Map-A9
Water Quality Impaired Streams	Map-A10
Entrenchment Condition/Floodplain Connectivity	Map-A11
Bank Erosion	Map-A12
Fine Sediment Condition	Map-A13
Riparian Condition	Map-A14
Large Woody Debris Condition	Map-A15
Percent Pool	Map-A16
Peak Flow Conditions	Map-A17

## **Appendix B: Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors**

Under the Salmon Recovery Act (passed by the legislature as House Bill 2496, and later revised by Senate Bill 5595), the Washington Conservation Commission (WCC) is charged with identifying the habitat factors limiting the production of salmonids throughout most of the state. This information should guide lead entity groups and the Salmon Recovery Funding Board in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Identifying habitat limiting factors requires a set of standards that can be used to compare the significance of different factors and consistently evaluate habitat conditions in each WRIA throughout the state.

In order to develop a set of standards to rate salmonid habitat conditions, several tribal, state, and federal documents that use some type of habitat rating system were reviewed (see Table 131). The goal was to identify appropriate rating standards for as many types of habitat limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the accepted standard was adopted by the WCC. For factors that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed, with the expectation that it will be modified or replaced as better data become available.

The ratings adopted by the WCC are presented in Table 132. These ratings are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in a WRIA. They also will hopefully provide a level of consistency between WRIs that allows habitat conditions to be compared across the state. However, for many habitat factors, there may not be sufficient data available to use a rating standard or there may be data on habitat parameters where no rating standard is provided. For these factors, the professional judgment of the TAG should be used to assign the appropriate ratings. A set of narrative standards will be developed in the near future to provide guidance in this situation.

In some cases there may be local conditions that warrant deviation from the rating standards presented here. This is acceptable as long as the justification and a description of the procedures that were followed are clearly documented in the limiting factors report. Habitat condition ratings specific to streams draining east of the Cascade crest were included where they could be found, but for many parameters they were not. Additional rating standards will be included as they become available. In the meantime, TAGs in these areas will need to work with the standards presented here or develop alternatives based on local conditions. Again, if deviating from these standards, the procedures followed should be clearly documented in the limiting factors report.

**Table 131. Source documents**

<b>Code</b>	<b>Document</b>	<b>Organization</b>
Hood Canal	Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Habitat Recovery Plan, Final Draft (1999)	Point No Point Treaty Council, Skokomish Tribe, Port Gamble S’Klallam Tribe, Jamestown S’Klallam Tribe, and Washington Department of Fish and Wildlife
ManTech	An Ecosystem Approach to Salmonid Conservation, vol. 1 (1995)	ManTech Environmental Research Services for the National Marine Fisheries Service, the US Environmental Protection Agency, and the US Fish and Wildlife Service
NMFS	Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast (1996)	National Marine Fisheries Service
PHS	Priority Habitat Management Recommendations: Riparian (1995)	Washington Department of Fish and Wildlife
Skagit	Skagit Watershed Council Habitat Protection and Restoration Strategy (1998)	Skagit Watershed Council
WSA	Watershed Analysis Manual, v4.0 (1997)	Washington Forest Practices Board
WSP	Wild Salmonid Policy (1997)	Washington Department of Fish and Wildlife

**Table 132. WCC salmonid habitat condition ratings**

<b>Habitat Factor</b>	<b>Parameter/Unit</b>	<b>Channel Type</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Source</b>
<b>Access and Passage</b>						
Artificial Barriers	% known/potential habitat blocked by artificial barriers	All	>20%	10-20%	<10%	WCC
<b>Floodplains</b>						
Floodplain Connectivity	Stream and off-channel habitat length with lost floodplain connectivity due to incision, roads, dikes, flood protection, or other	<1% gradient	>50%	10-50%	<10%	WCC
Loss of Floodplain Habitat	Lost wetted area	<1% gradient	>66%	33-66%	<33%	WCC
<b>Channel Conditions</b>						
Fine Sediment	Fines < 0.85 mm in spawning gravel	All – Westside	>17%	11-17%	? 11%	WSP/WSA/ NMFS/Hood Canal

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source																				
	Fines < 0.85 mm in spawning gravel	All – Eastside	>20%	11-20%	? 11%	NMFS																				
Large Woody Debris	pieces/m channel length	?4% gradient, <15 m wide (Westside only)	<0.2	0.2-0.4	>0.4	Hood Canal/Skagit																				
	or use Watershed Analysis piece and key piece standards listed below when data are available																									
	pieces/channel width	<20 m wide	<1	1-2	2-4	WSP/WSA																				
	key pieces/channel width*	<10 m wide (Westside only)	<0.15	0.15-0.30	>0.30	WSP/WSA																				
	key pieces/channel width*	10-20 m wide (Westside only)	<0.20	0.20-0.50	>0.50	WSP/WSA																				
	* Minumim size to qualify as a key piece:																									
	<table><tr><td></td><td><u>BFW (m)</u></td><td><u>Diameter (m)</u></td><td><u>Length (m)</u></td></tr><tr><td>0-5</td><td>0.4</td><td>8</td><td></td></tr><tr><td>6-10</td><td>0.55</td><td>10</td><td></td></tr><tr><td>11-15</td><td>0.65</td><td>18</td><td></td></tr><tr><td>16-20</td><td>0.7</td><td>24</td><td></td></tr></table>							<u>BFW (m)</u>	<u>Diameter (m)</u>	<u>Length (m)</u>	0-5	0.4	8		6-10	0.55	10		11-15	0.65	18		16-20	0.7	24	
		<u>BFW (m)</u>	<u>Diameter (m)</u>	<u>Length (m)</u>																						
0-5	0.4	8																								
6-10	0.55	10																								
11-15	0.65	18																								
16-20	0.7	24																								
Percent Pool	% pool, by surface area	<2% gradient, <15 m wide	<40%	40-55%	>55%	WSP/WSA																				
	% pool, by surface area	2-5% gradient, <15 m wide	<30%	30-40%	>40%	WSP/WSA																				

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
	% pool, by surface area	>15 m	<35%	35-50%	>50%	Hood Canal
Pool Frequency	channel widths per pool	<15 m	>4	2-4	<2	WSP/WSA
	channel widths per pool	>15 m	-	-	chann width 50' 75' 100'	pools/ mile 26 23 18
Pool Quality	pools >1 m deep with good cover and cool water	All	No deep pools and inadequate cover or temperature, major reduction of pool volume by sediment	Few deep pools or inadequate cover or temperature, moderate reduction of pool volume by sediment	Sufficient deep pools	NMFS/WS P/WSA
Streambank Stability	% of banks not actively eroding	All	<80% stable	80-90% stable	>90% stable	NMFS/WS P
Sediment Input						
Sediment Supply	m <sup>3</sup> /km <sup>2</sup> /yr	All	> 100 or exceeds natural rate*	-	< 100 or does not exceed natural rate*	Skagit
	* Note: this rate is highly variable in natural conditions					
Mass Wasting		All	Significant increase over natural levels for mass wasting events that deliver to stream	-	No increase over natural levels for mass wasting events that deliver to stream	WSA

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Road Density	mi/mi <sup>2</sup>	All	>3 with many valley bottom roads	2-3 with some valley bottom roads	<2 with no valley bottom roads	NMFS
Or use results from Watershed Analysis where available						
<i>Riparian Zones</i>						
Riparian Condition	<ul style="list-style-type: none"> <li>riparian buffer width (measured out horizontally from the channel migration zone on each side of the stream)</li> <li>riparian composition</li> </ul>	Type 1-3 and untyped salmonid streams >5' wide	<75' or <50% of site potential tree height (whichever is greater) OR Dominated by hardwoods, shrubs, or non-native species (<30% conifer) unless these species were dominant historically.	75'-150' or 50-100% of site potential tree height (whichever is greater) AND Dominated by conifers or a mix of conifers and hardwoods (≥30% conifer) of any age unless hardwoods were dominant historically.	<ul style="list-style-type: none"> <li>&gt;150' or site potential tree height (whichever is greater) AND</li> <li>Dominated by mature conifers (≥70% conifer) unless hardwoods were dominant historically</li> </ul>	WCC/WSP
	<ul style="list-style-type: none"> <li>buffer width</li> <li>riparian composition</li> </ul>	Type 4 and untyped perennial streams <5' wide	<50' with same composition as above	50'-100' with same composition as above	>100' with same composition as above	WCC/WSP
	<ul style="list-style-type: none"> <li>buffer width</li> <li>riparian composition</li> </ul>	Type 5 and all other untyped streams	<25' with same composition as above	25'-50' with same composition as above	>50' with same composition as above	WCC/WSP

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
<i>Water Quality</i>						
Temperature	degrees Celsius	All	>15.6° C (spawning)  >17.8° C (migration and rearing)	14-15.6° C (spawning)  14-17.8° C (migration and rearing)	10-14° C	NMFS
Dissolved Oxygen	mg/L	All	<6	6-8	>8	ManTech
<i>Hydrology</i>						
Flow	hydrologic maturity	All	<60% of watershed with forest stands aged 25 years or more	-	>60% of watershed with forest stands aged 25 years or more	WSP/Hood Canal
		<b>or use results from Watershed Analysis where available</b>				
	% impervious surface	Lowland basins	>10%	3-10%	≤3%	Skagit
<i>Biological Processes</i>						
Nutrients (Carcasses)	Number of stocks meeting escapement goals	All Anadromous	Most stocks do not reach escapement goals each year	Approximately half the stocks reach escapement goals each year	Most stocks reach escapement goals each year	WCC
<i>Lakes (further work needed)</i>						
<i>Estuaries (further work needed)</i>						

## **Appendix C: Fish Distribution Definitions**

The following definitions were used to develop fish distribution maps for WRIA 26:

### Known

Habitat that is documented to presently sustain fish populations (published sources, survey notes, first-hand sightings, etc.): or, habitat with records of fish use (which may or may not be known to have been extirpated for some reason). This includes habitat used by all life history stages for any length of time (i.e. intermittent streams which contain water during flood flows that provides refuge habitat for a period of hours or days).

### Presumed

Habitat with no records of known fish use, but that is below any known natural barrier (including sustained 12% gradient) and otherwise conforms to species-specific habitat criteria.

### Potential

Habitat above human-caused blockages or obstructions that could be opened to fish use and that is below any known natural barrier (including sustained 12% gradient) and otherwise conforms to species-specific habitat criteria.

### Artificial

Includes habitat with Known presence of salmonids that are supported by an active fish passage operation (such as a trap and haul facility) or a structure providing passage around a dam or natural passage barrier. Known habitat occupied exclusively by hatchery outplants or strays may also be included.

## **Appendix D: Cowlitz/Wahkiakum Conservation District Stream Survey Protocols**

Stream survey data for Cowlitz and Wahkiakum Counties was collected using protocols described in Appendix D. In order to fit the stream survey data to the Washington State Conservation Commission Salmonid Habitat Condition Rating Standards for Identifying Limiting Factors (Appendix B), assumptions were necessary. The purpose of this appendix is to guide the reader through the process used to fit the data to the criteria. The following information is provided by survey protocol and habitat factor as it appears in the list of rating standards (criteria).

Under both protocols, data was collected over a 1000-foot survey segment (segment). Although data within a segment was often collected by location of occurrence or at predetermined intervals, habitat condition was assessed at the segment level. Ratings were then applied to digitized segments to provide a visualization of habitat condition.

### **Stream Survey Protocol**

#### Access and Passage

*Artificial Barriers:* The stream survey protocol collected information that allowed for an elementary assessment of potential barriers by applying state standards for outlet height and slope/length criteria to the data set. However, the data was not used as the principal source of data used to identify barriers. Rather, the data was used to supplement the technical advisory group's knowledge by providing information from which they could render an opinion or confirm an observation. Data tables were generated providing available information for culverts and potential natural barriers including:

Location -	stream segment identifier and footage within the segment
Type of barrier -	culvert, falls, cascade...
Height of barrier -	For culverts, height refers to the outlet height. For natural barriers, height refers to the vertical change in elevation
Slope -	Culvert slope or slope of a cascade
Length -	Length of the culvert or cascade
Comments -	Any notes the field technician provided for the site
Passage -	A judgement call of the field technician of whether the site was passable, impassible or unknown

#### Floodplains/Entrenchment

*Floodplain Connectivity:* Valley bottom width and ordinary high water width measurements were collected at 200 foot intervals within the 1,000-foot survey segment. Entrenchment ratios (valley bottom width/ordinary high water width) were calculated for

the 200-foot observations then averaged to obtain an estimate for the segment. This data was only collected for streams within Cowlitz County.

Rosgen (1996) entrenchment values, as adapted from the NRCS Stream Restoration Handbook, were used to apply a Good, Fair, and Poor rating. The rating used is:

Good	Fair	Poor
$\geq 2.2$ width to depth ratio	$>1.4$ and $<2.2$ width/depth	$<1=1.4$

NOTE: The ratings were applied to all stream segments. Information was not available to discern channel types or channel confinement. In the lower watersheds (unconfined channel types) the ratings provide an indication of entrenchment. For segments in the upper watershed (confined channel types) the values represent more of a level of confinement.

The amount of lost floodplain habitat could not be estimated from the survey data.

#### Substrate Sediment Conditions

*Fine Sediment:* Stream survey estimates of fine sediment included two categories, sand and sediment. The stream survey defined sand as anything less than 0.2 inches and sediment more of a qualitative flour texture (feel).

The Habitat Rating Standard defined fine sediment as anything less than .85 mm, which under most sediment size classifications is considered fine sand.

The percent sand and percent sediment for each stream segment from the stream survey data was combined and the rating criteria applied to the resultant. Combining both sand and sediment resulted in a substantial decrease in the number of stream segments rated as “good” and an increase in segments rated both “fair” and “poor” (see Table 133).

**Table 133: Sediment rating comparison**

Rating	Sediment Only (# of segments)	Sand Only (# of segments)	Sediment plus Sand (# of segments)	Percent Change Sediment to Combined
Good	253	234	80	-216%
Fair	44	64	104	+58%
Poor	83	82	196	+58%
Total Segments	380	380	380	

The substantial increase in segments rated poor when sediment and sand was combined is due to the physical distribution of segments in the field and may also be exacerbated by the tendency of stream surveyors to lump sediment sizes. Texture (how it feels) is the principal tool stream surveyors had to differentiate sediment size. In low gradient segments fine sediment takes on a flour feel indicating the increased presence of

sediment (silts/clays). As stream gradient increases, the coarser sand size is more readily observed and the texture becomes gritty. Even though there may be considerable silt and clay fraction, the gritty feel prompts classification into the sand category.

### Large Woody Debris

The criterion for key pieces per channel width from the Conservation Commission's habitat rating standards (see Appendix B) was applied to the Cowlitz CD stream survey data.

The number of channel widths for each segment was determined by averaging five ordinary high water width measurement (measured every 200 feet) and dividing into the 1,000-foot segment length. Rating criteria were applied to individual log measurements to determine whether it met the definition of a key piece. The average ordinary high water width for the segment was used as a surrogate for bank full width in applying the criteria. Debris jams were considered to function as a key piece of LWD within the segment. Logs and debris jams were summed for the segment and divided by the number of channel widths to obtain "key pieces per channel width". Rating criteria were applied to these values to assign a condition to the segment.

### Percent Pools

The length of pool habitat surveyed was summed for each reach then divided by reach length (1,000 feet) to calculate the percent pool. This approach assumes that the channel and pool width is constant throughout the reach. This approach likely yields an overestimate of percent pools to be applied to the criteria.

### Streambank Stability/Bank Erosion

Actively eroding streambanks were identified as part of the stream survey protocol. Surveyors were instructed to look for evidence that the soil was moving into the stream such as clumps of sod along the waters edge, fine sediment accumulations around and immediately downstream of the site, undercut banks, and to KICK the bank. If their toes easily dislodges or dents the streambank material it is susceptible to erosion. Although vastly different than stability, the criterion was applied to the stream survey data to obtain an indication of streambank erosion concerns. The TAG was relied upon to provide insight as to areas with streambank stability concerns. The percent of active erosion was subtracted from 100 to yield a percent of streambank not eroding. The rating criteria were applied directly to the resulting value.

### Riparian Condition

Stream survey data was collected based upon emergency rule definition of salmon bearing waters. Therefore the riparian buffer width and riparian composition criteria for

Type 1-3 water and salmonid streams >5 feet wide was applied to all of the stream survey reaches.

Stream survey information was collected by stream length over which Riparian characteristics remained similar. Riparian buffer width, percent composition, and diameter at breast height were averaged for the reach on a weighted basis. The weight was the length of stream.

Example:

Stream Length	Buffer width
0-200	50
200-500	100
500-1000	60

Weighted average =  $[(200*50) + (300*100) + (500*60)]/1000 = 70$   
This was done for each parameter buffer width, percent conifer, diameter at breast height. The rating criteria were/was applied to the resulting values.

The width criteria and species composition was applied directly to the data set with one assumption. Diameter at breast height was used as a surrogate for “mature” under good riparian conditions. Sixteen (16 inches) inches was used as the diameter at which a conifer was deemed “mature”. This value corresponds with the minimum diameter for a log to be classified as a “key piece” of LWD.

## GLOSSARY

**303 (d) List:** The federal Clean Water Act requires states to maintain a list of stream segments that do not meet water quality standards. The list is called the 303(d) list because of the section of the Clean Water Act that makes the requirement.

**Adaptive management:** Monitoring or assessing the progress toward meeting objectives and incorporating what is learned into future management plans.

**Adfluvial:** Migratory between lakes and rivers or streams or, life history strategy in which adult fish spawn and juveniles subsequently rear in streams but migrate to lakes for feeding as subadults and adults. Compare fluvial.

**Administratively Withdrawn Areas:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Administratively Withdrawn Areas are identified in current Forest and District Plans or draft plan preferred alternatives and include recreation and visual areas, back county, and other areas where management emphasis precludes scheduled timber harvest.

**Aggradation:** The geologic process of filling and raising the level of the streambed or floodplain by deposition of material eroded and transported from other areas.

**Alevins (also sac fry or yolk-sac fry):** Larval salmonid that has hatched but has not fully absorbed its yolk sac, and generally has not yet emerged from the spawning gravel. Absorption of the yolk sac, the alevin's initial energy source, occurs as the larva develops its mouth, digestive tract, and excretory organs and otherwise prepares to feed on natural prey.

**Alluvial:** Deposited by running water.

**Alluvial fan:** A relatively flat to gently sloping landform composed of predominantly coarse grained soils, shaped like an open fan or a segment of a cone, deposited by a stream where it flows from a mountain valley onto a plain or broader valley, or wherever the stream gradient suddenly decreases. Alluvial fans typically contain several to many unconfined, distributary channels that migrate back and forth across the fan over time. This distribution of flow across several stream channels provide for less erosive water velocities, maintaining and creating suitable rearing salmonid habitat over a wide range in flows. This landform has high subsurface water storage capacity. They frequently adjoin terraces or floodplains.

**Anadromous fish:** Species that are hatched in freshwater mature in saltwater, and return to freshwater to spawn.

**Anchor ice:** Forms along the channel bottom from the accumulation of frazil ice particles on the rough surfaces of coarse bottom sediments and on the lee sides of pebble, cobbles, and boulders.

Aquifer:

1. A subsurface layer of rock permeable by water. Although gravel, sand sandstone and limestone are the best conveyors of water, the bulk of the earth's rock is composed of clay, shale and crystalline.
2. A saturated permeable material (often sand, gravel, sandstone or limestone) that contains or carries groundwater.
3. An underground, water-bearing layer of earth, porous rock, sand, or gravel, through which water can seep or be held in natural storage. Aquifers generally hold sufficient water to be used as a water supply.

Basin: The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

Basin flow: Portion of stream discharge derived from such natural storage sources as groundwater, large lakes, and swamps but does not include direct runoff or flow from stream regulation, water diversion, or other human activities.

Bioengineering: Combining structural, biological, and ecological concepts to construct living structures for erosion, sediment, or flood control.

Biological Diversity (biodiversity): Variety and variability among living organisms and the ecological complexes in which they occur; encompasses different ecosystems, species, and genes.

Biotic Integrity: Capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region; a system's ability to generate and maintain adaptive biotic elements through natural evolutionary processes.

Braided stream: Stream that forms an interlacing network of branching and recombining channels separated by branch islands or channel bars.

Buffer: An area of intact vegetation maintained between human activities and a particular natural feature, such as a stream. The buffer reduces potential negative impacts by providing an area around the feature that is unaffected by this activity.

Capacity: the amount of available habitat for a specific species or lifestage within a given area. Capacity is a density-dependent measure of habitat quantity.

Carrying capacity: Maximum average number or biomass of organisms that can be sustained in a habitat over the long term. Usually refers to a particular species, but can be applied to more than one.

Channelization: Straightening the meanders of a river; often accompanied by placing riprap or concrete along banks to stabilize the system.

**Channelized stream:** A stream that has been straightened, runs through pipes or revetments, or is otherwise artificially altered from its natural, meandering course.

**Channel Migration Zone:** lateral movement of channel leads to a sequence of events through time where terraces are formed and new floodplain areas are defined.

**Channel Stability:** Measure of the resistance of a stream to erosion that determines how well a stream will adjust and recover from changes in flow or sediment transport.

**Check dams:** Series of small dams placed in gullies or small streams in an effort to control erosion. Commonly built during the 1900s.

**Confinement:** When a channel is fixed in a specific location restricting its pattern of channel erosion and migration

**Confluence:** the flowing together of two or more streams, or the combined stream formed by the conjunction.

**Congressionally Reserved Areas:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). These areas include Wildernesses, Wild and Scenic Rivers, National Monuments, as well as other federal lands not administered by the Forest Service or BLM.

**Connectivity:** Unbroken linkages in a landscape, typified by streams and riparian areas.

**Constriction:** The narrowing of a channel that impedes the downstream movement of water or debris, as in a small culvert crossing.

**Critical Stock:** A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

**Depressed Stock:** A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.

**Debris torrent:** A type of landslide characterized by water-charged, predominantly coarse grained soil and rock fragments, and sometimes large organic material, flowing rapidly down a pre-existing channel.

**Degradation:** The lowering of the streambed or widening of the stream channel by erosion.

**Deposition:** The settlement of material out of the water column and onto the streambed.

**Distributaries:** A river branch flowing away from the main stream.

**Diversity:** Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems. See *species richness*.

**Ecological restoration:** Involves replacing lost or damaged biological elements (populations, species) and reestablishing ecological processes (dispersal, succession) at historical rates.

**Ecosystem:** Biological community together with the chemical and physical environment with which it interacts.

**Ecosystem management:** Management that integrates ecological relationships with sociopolitical values toward the general goal of protecting or returning ecosystem integrity over the long term.

**Emigration:** to leave a place

**Endangered Species Act:** A 1973 Act of Congress that mandated the protection and restoration of endangered and threatened species of fish, wildlife and plants.

**Endangered Species:** Any species which is in danger of extinction throughout all, or a significant portion of its range, other than a species of the Class Insecta, as determined by the Secretary to constitute a pest.

**Escapement:** Those fish that have survived all fisheries and will make up a spawning population.

**Estuarine:** Of, or relating to, or formed in an estuary.

**Estuary:** A partly enclosed coastal body of water that has free connection to open sea, and within which seawater is measurably diluted by fresh river water.

**Eutrophic:** Pertaining to a lake or other body of water rich in dissolved nutrients, photosynthetically productive, and often deficient in oxygen during warm periods. Compare *oligotrophic*.

**Evolutionary Significant Unit (ESU):** A definition of a species used by National Marine Fisheries Service (NMFS) in administering the Endangered Species Act. An ESU is a population (or group of populations) that is reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species.

**Extirpation:** The elimination of a species from a particular local area.

**Flood:** A rising and overflowing of a body of water especially onto normally dry land.

**Floodplain:** The low-lying, topographically flat area adjacent to a stream channel which is regularly flooded by stream water on a periodic basis and which shows evidence of the action of flowing water, such as active or inactive flood channels, recent fluvial soils, rafted debris or tree scarring. It varies in width depending on size of river, relative rates of downcutting and resistance of the bedrock in the valley walls.

Flow regime: Characteristics of stream discharge over time. Natural flow regime is the regime that occurred historically.

Fluvial: Of or pertaining to, or living in streams or rivers; also, organisms that migrate between main rivers and tributaries. Compare *adfluvial*.

Frazil ice: Thin particles of ice suspended in the water. Produced where extensive channel ice is formed and the freezing supercools the stream water producing nuclei of “frazil ice” particles.

Genetic Diversity Unit (GDU) is defined as: A group of genetically similar stocks that is genetically distinct from other such groups. The stocks typically exhibit similar life histories and occupy ecologically, geographically and geologically similar habitats. A GDU may consist of a single stock

Geomorphology: Study of the form and origins of surface features of the Earth.

Glacial Outwash/Glacial Fluvial Outwash: Nearly level terraces and floodplains in large valley bottoms. Slope is generally less than 10%. The terraces and floodplains were leveled by river flooding induced by melting of glaciers. They are dissected by high-energy, low-gradient, perennial streams. Channels may be braided. Channel deposits are usually comprised of moderately to well sorted sand to cobble size deposits but may include boulders. Ponds, marshes and overflow channels occur with a range of finer grained deposits. This landform is subject to frequent flooding. It has a high subsurface flow rate. Subsurface and instream flow may be in continuity. They are stable but soils on terrace escarpments may unravel. This landform commonly adjoins but can include alluvial fans and colluvial deposits along valley sides.

Glacial Till: A very dense, poorly sorted mixture of clay, silt, sand and gravel deposited directly beneath glacial ice.

Glides: Stream habitat having a slow, relatively shallow run of water with little or no surface turbulence.

Healthy Stock: A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.

Hydrologic Unit Code (HUC): classification system used to describe the sub-division of hydrologic units. The codes represent the four levels of classification in the hydrologic unit system. The first level divides the US into 21 major geographic areas, or regions, based on surface topography, containing the drainage area of a major river or series of rivers. The second level divides the 21 regions into 222 sub-regions, which includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin or, a group of streams forming a coastal drainage area. The third level subdivides many of the subregions into accounting units. These 352 units nest within, or are equivalent to, the sub-regions. The fourth level is the cataloging unit, a geographic area representing part or all of a surface drainage basin, a combination of basins, or a distinct

hydrologic feature. These units subdivide the sub-regions and accounting units into approximately 2150 smaller areas.

Hydrograph: A graphic representation or plot of changes in the flow of water or in the elevation of water levels plotted against time.

Hydrology: Study of the properties, distribution, and effects of water on the Earth's surface, subsurface, and atmosphere.

Interagency Aquatic Database and GIS: contains Stream Inventory information from the USFS, Oregon Department of Fish and Wildlife, and the Bureau of Land Management and can be sorted by stream width and stream gradient.

Intermittent stream: Stream that has interrupted flow or does not flow continuously. Compare *perennial stream*.

Interstitial spaces: Space or openings in substrates that provide habitat and cover for bottom dwelling organisms, like young salmonids.

Intraspecific interactions: Interactions within a species.

Large Woody Debris (LWD): Any large piece of relatively stable woody material having a diameter greater than 10 cm and a length greater than 3 meters. LWD is an important part of the structural diversity of streams. The nature and abundance of LWD in a stream channel reflects past and present recruitment rates. This is largely determined by the age and composition of past and present adjacent riparian stands. Synonyms include: Large Organic Debris (LOD) and Coarse Woody Debris (CWD). Specific types of large woody debris include:

Affixed logs: Single logs or groups of logs that are firmly embedded, lodged, or rooted in a stream channel.

Deadheads: Logs that are not embedded, lodged or rooted in the stream channel but are submerged and close to the surface.

Digger log: Log anchored to the stream banks and/or channel bottom in such a way that a scour pool is formed.

Free logs: Logs or groups of logs that are not embedded, lodged or rooted in the stream channel.

Rootwad: The root mass of the tree.

Snag: A standing dead tree, or, a sometimes a submerged fallen tree in large streams. The top of the tree is exposed or only slightly submerged.

Sweeper log: Fallen tree whose bole or branches form an obstruction to floating objects.

**Large Woody Debris Recruitment:** The standing timber adjacent to the stream that is available to become large woody debris. Activities that disturb riparian vegetation including timber removal in riparian areas can reduce LWD recruitment. In addition, current conditions also reflect the past history of both natural and management-related channel disturbances such as flood events, debris flows, splash damming and stream clean-out.

**Lateral Moraine:** Hummocky, rolling glacial till deposits typically located in recesses along the mid-slopes of glacial trough walls. Slope is generally 25-40%. These deposits are usually not compacted. The slopes are dissected by poorly defined streams in a dendritic to deranged drainage pattern. They have a high subsurface water storage capacity and may be good shallow aquifers. Surface runoff is limited. Wet areas commonly occur in swales. Subsurface water is often diverted to depressional areas.

**Late-Successional Reserves (LSR's):** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Late-Successional Reserves are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl. Limited stand management is permitted.

**Limiting Factor:** Single factor that limits a system or population from reaching its highest potential.

**Macroinvertebrates:** Invertebrates large enough to be seen with the naked eye (e.g., most aquatic insects, snails, and amphipods).

**Managed Late-Successional Reserves (MLSR):** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Managed Late-Successional Reserves are identified for certain locations in drier provinces where regular and frequent fire is a natural part of the ecosystem. Like LSRs, MLSRs are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl. Certain silvicultural treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or diseased or insect epidemics.

**Mass wasting:** Landslide processes, including debris falls, debris slides, debris avalanches, debris flows, debris torrents, rockfalls, rockslides, slumps and earthflows, and all the small scale slumping collapse and raveling of road cuts and fills.

**Matrix:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). The matrix consists of those federal lands outside of the six categories of designated areas (Congressionally Reserved Areas, Late-Successional Reserves, Adaptive Management Areas, Managed Late-Successional Area, Administratively Withdrawn Areas, and Riparian Reserves). Most

timber harvest and other silvicultural activities would be conducted in that portion of the matrix with suitable forest lands, according to standards and guidelines. Most timber harvest takes place in the matrix.

Moraine: See “Terminal Moraine”.

Native: Occurring naturally in a habitat or region; not introduced by humans.

Non-Point Source Pollution: Polluted runoff from sources that cannot be defined as discrete points, such as areas of timber harvesting, surface mining, agriculture, and livestock grazing.

Oligotrophic: Pertaining to a lake or other body of water characterized by extremely low nutrient concentrations such as nitrogen or phosphorous and resulting in very moderate productivity.

Parr: Young trout or salmon actively feeding in freshwater; usually refers to young anadromous salmonids before they migrate to the sea. See *smolt*.

Plunge pool: A pool created by water passing over or through a complete or nearly complete channel obstruction, and dropping vertically, scouring out a basin in which the flow radiates from the point of water entry.

Pocket water: A series of small pools surrounded by swiftly flowing water, usually caused by eddies behind boulders, rubble, or logs, or by potholes in the streambed.

Pool: Portion of a stream with reduced current velocity, often with deeper water than surrounding areas and with a smooth surface.

Pool:riffle ratio: Ratio of the surface area or length of pools to the surface area or length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

Population: Organisms of the same species that occur in a particular place at a given time. A population may contain several discrete breeding groups or stocks.

Productivity: A measure of habitat quality which varies by species and lifestage. Productivity is a density-independent measure of habitat quality. Examples include, water temperature, water discharge, channel complexity, riparian condition, etc.

Rain-on-snow events: The rapid melting of snow as a result of rainfall and warming ambient air temperatures. The combined effect of rainfall and snow melt can cause high overland stream flows resulting in severe hillslope and channel erosion.

Rearing habitat: Areas required for the successful survival to adulthood by young animals.

Recovery: The return of an ecosystem to a defined condition after a disturbance.

**Redds:** Nests made in gravel (particularly by salmonids) for egg deposition consisting of a depression that is created and then covered.

**Rehabilitation:** Returning to a state of ecological productivity and useful structure, using techniques similar or homologous in concept; producing conditions more favorable to a group of organisms or species complex, especially that economically and aesthetically desirable flora and fauna, without achieving the undisturbed condition.

**Resident fish:** Fish species that complete their entire life cycle in freshwater.

**Riffle:** Stream habitat having a broken or choppy surface (white water), moderate or swift current, and shallow depth.

**Riparian:** Pertaining to the banks and other adjacent, terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, and surface-emergent aquifers, whose imported waters provide soil moisture significantly in excess of that otherwise available through local precipitation – soil moisture to potentially support a mesic vegetation distinguishable from that of the adjacent more xeric upland.

**Riparian Area:** The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains which support riparian vegetation.

**Riparian Habitat Conservation Areas (RHCA):** Portions of watersheds where riparian-dependent resources receive primary emphasis, and management activities are subject to specific standards and guidelines. The RHCA's include traditional riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris and nutrient delivery systems (USFS AND BLM 1995/ PACFISH)

**Riparian Reserves:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994/ Northwest Forest Plan). The Riparian Reserves provide an area along all stream, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.

**Riparian Vegetation:** Terrestrial vegetation that grows beside rivers, streams and other freshwater bodies and that depends on these water sources for soil moisture greater than would otherwise be available from local precipitation.

**Riprap:** Large rocks, broken concrete, or other structure used to stabilize streambanks and other slopes.

**Rootwad:** Exposed root system of an uprooted or washed-out tree.

**Run:** An area of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

**SaSI (Salmonid Stock Inventory):** A list of Washington's naturally reproducing salmonid stocks and their origin, production type, and status. Developed in 1998 as an appendix to SASSI to include bull trout and Dolly Varden; formerly named SASSI.

**SASSI (Salmon and Steelhead Stock Inventory):** A list of Washington's naturally reproducing salmon and steelhead stocks and their origin, production type, and status; developed in 1992.

**SSHIAP (Salmon, Steelhead Habitat Inventory and Assessment Project):** A partnership based information system that characterizes distribution and freshwater habitat conditions of salmonid stocks in Washington.

**Salmonid:** Fish of the family salmonidae, including salmon, trout chars, and bull trout.

**Salmon:** Includes all species of the family Salmonid

**Sediment:** Material carried in suspension by water, which will eventually settle to the bottom.

**Sedimentation:** The process of subsidence and deposition of suspended matter carried in water by gravity; usually the result of the reduction in water velocity below the point at which it can transport the material in suspended form.

**Seral stages:** Series of relatively transitory plant communities that develop with ecological succession from bare ground to the climax plant community stage.

**Side channel:** Lateral channel with an axis of flow roughly parallel to the mainstem, which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel. Side channel habitat may exist either in well defined secondary (overflow) channels or in poorly defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.

**Sinuosity:** Degree to which a stream channel curves or meanders laterally across the land surface. Can be determined by the ratio of the stream length to valley floor, or, the ratio of the channel length between two points on a channel to the straight line distance between the same points.

**Slope:** Water surface slope is determined by measuring the difference in water surface elevation per unit stream length. Typically measured through at least twenty channel widths or two meander wavelengths.

**Slope stability:** The degree to which a slope resists the downward pull of gravity.

**Smolt:** Juvenile salmonid, 1 or more years old, migrating seaward; a young anadromous trout, salmon, or char undergoing physiological changes that will allow it to change from life in freshwater to life in the sea. The smolt stage follows the parr stage. See *parr*.

**Stock:** Group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction. Generally, a local population of fish. More specifically, a local population – especially that of salmon, steelhead (rainbow trout), or other anadromous fish – that originates from specific watersheds as juveniles and generally returns to its birth streams to spawn as adults.

**Stream Number:** A unique six-digit numerical stream identifier, with the first two digits representing the WRIA and the last four digits representing the unique stream identifier from the WDF Stream Catalog (Williams et al. 1975) where available. For streams where the Stream Catalog does not provide a stream identified: (1) unassigned numbers in the sequence are used; or (2) an additional single-character alpha extension may be added to the end of the four-digit stream identifier for the next downstream numbered stream. Alpha extensions are generally used for tributaries to a numerically identified stream proceeding from downstream to upstream.

**Stream Order:** A classification system for streams based on the number of tributaries it has. The smallest unbranched tributary in a watershed is designated Order 1. A stream formed by the confluence of two order 1 streams is designated Order 2. A stream formed by the confluence of two order 2 streams is designated Order 3; and so on.

**Stream Reach:** a homogeneous segment of a drainage network characterized by uniform channel pattern, gradient, substrate and channel confinement.

**Substrate:** mineral and organic material forming the bottom of a waterway or water body.

**Subwatershed:** One of the smaller watersheds that combine to form a larger watershed.

**Supplementation:** the collection, rearing, and release of locally adapted salmon in ways that promote ecologic and genetic compatibility with the naturally produced fish.

**Terminal Moraine:** A low-relief, linear deposit of glacial till. These occur on valley bottoms and are laid down at the terminal end of a glacier as forward progress ends and marks the furthest extension of the glacier. Moraines have moderate to high subsurface water storage capacity.

**Terrace:** Abandoned floodplain.

**Thalweg:** The path of maximum depth in a river or stream.

**Watershed:** An area so sloped as to drain a river and all its tributaries to a single point or particular area. The total area above a given point on a watercourse that contributes water to its flow.

**Watershed restoration:** Reestablishing the structure and function of an ecosystem, including its natural diversity; a comprehensive, long-term program to return watershed health, riparian ecosystems, and fish habitats to a close approximation of their condition prior to human disturbance.

Watershed-scale approach: Consideration of the entire watershed in a project or plan.

Weir: Device across a stream to divert fish into a trap or to raise the water level or divert its flow. Also a notch or depression in a dam or other water barrier through which the flow of water is measured or regulated.

Width-depth ratio: Describes the dimension and shape factor as the ratio of bankfull channel width to bankfull mean depth.

Wild Stock: A stock that is sustained by natural spawning and rearing in the natural habitat regardless.